DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY A. S. RUSSELL, M.C., D.Sc.

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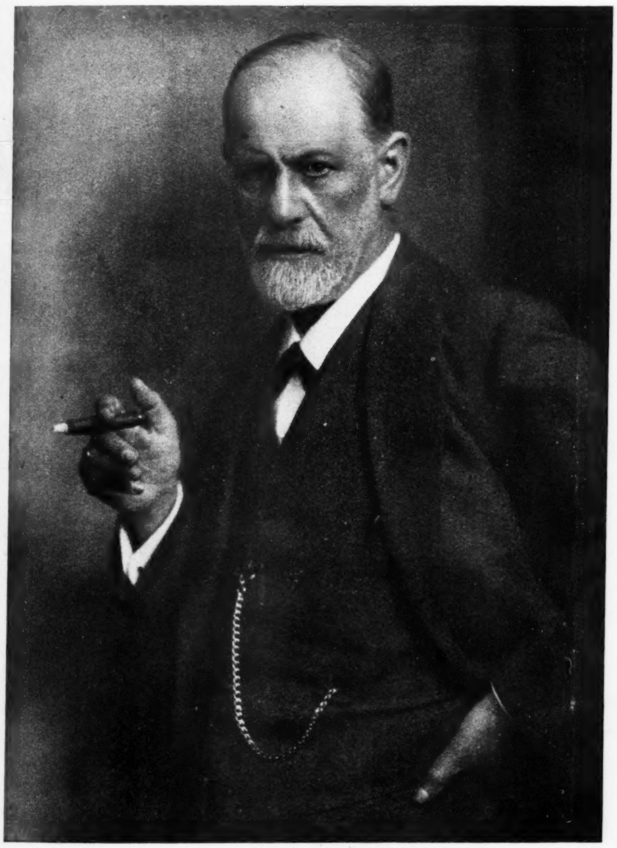

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JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

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Editorial Notes

There is promise of a great adventure next year. A joint committee of the Alpine Club and of the Royal Geographical Society has been formed to organise an expedition to climb Mount Everest, the highest mountain in the world. It is proposed [1] to send out a reconnaissance party to Tibet this year to make a real, thorough survey of the whole situation, to find out as much as possible about the country around Everest, about the mountain itself, and about the climatic conditions that prevail in those promiscuous parts, and next year if all goes well to send out a climbing party. It is a big undertaking, but so little is really known of the geography of that part of the world that a thorough reconnaissance is an absolutely essential preliminary to the full assault of the mountain.

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If all goes well this year, then, we may reasonably hope that Everest may be climbed next year. Difficulties in the past have been of two kinds, political and natural. The former have at last been overcome, and the latter may now be closely and scientifically studied. High risks will have to be run and uncommonly severe hardships endured—risks from icy slopes, from rocky precipices, and avalanches; hardships from intense cold, from terrific winds, and from blinding snowstorms. Even were all these difficulties magically annulled while the climbing party were making the ascent, there would still remain the grave difficulties due to the diminished pressure of air at high elevations. Everest is 29,002 feet high (as we learned at school), and no man has ascended a mountain within 4,000 feet of this height. No man knows, therefore, the capacity of a human being to stand great exertion at this altitude. It can be learned by actual experience only.

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The approaches to the mountain are as yet unknown to Europeans. Few, indeed, have ever seen the peak. But the most likely approach seems to be from the Tibet side. Colonel Howard Bury, who has recently been out there and who has been appointed Chief of the Expedition, recommends the route from Darjeeling via Phari, Kampa Dzong, and Tingri Dzong. On this route pack transport of mules, ponies, or yaks could be used the whole way. The members of the reconnaissance party going out this year can test this point and find out what pack animals can thrive best, work best, be most sure-footed, and stand the altitude with least fatigue. They can also decide what natives are most likely to be of the greatest assistance in the climb. They will have to explore with the greatest care all the approaches, and to examine, photograph, and map the mountain itself in fullest detail. They have a piece of work to do which demands high physical, moral, and scientific qualities.

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In this work it is not considered probable that the aeroplane will be of much assistance. A reconnaissance of the southern slopes of the mountain could be made by flying up the Arun valley from the plains of India, but the difficulty of this is the provision of an aerodrome at the foot of the hills. There is none there now. The nearest is at Calcutta or Allahabad, and funds for building a nearer one are not available. Reconnaissance by aeroplane from the Tibet side of the mountain is prevented for another reason. For in the high land

[1] See *The Geographical Journal*, February, 1921, pp. 73, 121.

of that country the density of the atmosphere is only about one-half of that at sea-level, and no aeroplane of the present type would rise from the ground.

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However, some of the difficulties that seem to face the party at present may disappear: others, unforeseen, may arise. It would not be an adventure if everything was seen or foreseen. The expedition has the cordial co-operation of the Government of India and more particularly of the Surveyor-General. With this assistance and that of the two Societies which are going to find the £10,000 necessary for the work of two years, the expedition starts under better auspices than have favoured any previous attempt to climb a high Himalayan peak. Everyone who can see the importance of any further step towards the mastery of our surroundings will wish this expedition success.

* * * * *

I have lately looked through a very able book [1] in which water-divining, one of the subjects in which I am interested, is spoken of rather disrespectfully. A book like this which deals with Spiritism is very timely, for we are getting rather tired of those people who give such profuse *material* details of the "life beyond" in the Sunday newspapers and the popular monthly magazines. Dr. Culpin in this book attempts to give an explanation of it all in terms of recent work on psychology. "My object in writing this book," he says in the preface—and it is a good thing to have an object in writing a book nowadays—"is to present an explanation of so-called occult phenomena, concerning which credulity is still as busy as in the days of witchcraft. The producers of these phenomena have been exposed efficiently and often, but their supporters are as active as ever, and show a simple faith which is more convincing than any argument. Moreover, the producers themselves—mediums, clairvoyants, water-diviners, seers, or whatever they may be—are sometimes of such apparent honesty and simplicity that disbelief seems almost a sacrilege; therefore part of my aim is to show how a man believing firmly in his own honesty may yet practise elaborate trickery and deceit."

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He then introduces the views on the subjects of the unconscious, the formation of complexes, and of forgetting and repression which are held by most psychologists to-day. With these I do not propose to deal. But if one understands such subjects of the new psychology as "dissociation," "suggestion," and the "unconscious," one may easily follow Dr. Culpin as he expounds his views. I am not sure, however, that Dr. Culpin's explanation of water-divining is as convincing as that of some of the other subjects with which he deals. I think that two subjects, water-divining and telepathy, are rather held in disrepute because they are associated with the quackery of spiritism.

* * * * *

Dr. Culpin looks upon the water-diviner as a species of clown whose object in divining is primarily to show off to an admiring audience, to behave in a queer way that he may become a centre of interest. The audience is there to encourage him, and to slap him on the back when he apparently achieves a success. It has a peculiar kind of memory, for while it remembers the cases successfully demonstrated, it speedily forgets the cases of failure. So does the water-diviner. He himself is not consciously deceiving his audience. He is no doubt quite in earnest: but he is unconsciously a deceiver. Originally he must have known how evil it is to deceive others, but this unpleasant thought has been carefully repressed and hence forgotten, so that the knowledge of his deceit does not occur to him in the conscious state, and an affirmation on his part that he is acting honestly is quite worthless. But why does he do all this? For notoriety, to have power, to feel superior, to be something exceptional. And why does the twig, which in the hands of the water-diviner twists upwards when he locates the water, move as it does? Because the diviner, while apparently holding it down for all he is worth, really has it in such a sensitive position that a very little movement actually forces it up. This little movement is supplied unconsciously by a desire to trick and no doubt by a clever appreciation of impressions received from the audience.

* * * * *

Now this is a very ingenious theory, and even although I cannot state it as clearly as the author does, his main point, that water-divining is a fraud, is indicated sufficiently. And so the argument falls to the ground if the water-diviner really does know when underground water is below him and when it is not. I think the explanation which agrees most closely with the facts is to say that the water-diviner has a genuine gift which is a new or rare *sense*. He does find water; he can trace underground streams accurately. When he says water is in a certain place, it is there; when he denies this, it is not there. Give him an area to investigate and sufficient time to work and he can map the underground streams, show their relation to, or independence of, each other and to springs. Sink your shaft at suitable points of the underground stream and there, sure enough, is the water. In the light of such facts, if one regards the diviner as an honest man but unconsciously a trickster, one may apply the same argument to any investigator. One may deny, for

[1] *Spiritualism and the New Psychology*. By Millais Culpin. (Arnold, 6*s*.)

example, the reality of atoms and regard the theory and experiment connected with them as an ingenious superstition in which many apparently excellent people seemingly believe and about which they are apparently very consistent, no doubt because it suits their book, attracts attention to themselves, and provides them with very nice posts at the Universities!

* * * * *

If one believes, as most psychologists do, that we are only partially awake, or that we are only now emerging from what is analogous to a pre-natal sleep, one need not get unduly excited because some men seem to have gifts which the rest of us lack. If water-divining is some kind of sense it must necessarily be a difficult thing to investigate. All senses are. Think how hard it would be for a man with sight to explain his gift to a blind world. How wonderful a man with a sense of smell would appear to us, supposing that none of us could smell! He could tell, for example, liquid ammonia from alcohol or from water correctly every time, without shaking them, tasting them, weighing them, or doing chemical analyses of them, as we should require to do, simply by bringing his nose into the vicinity of each in turn. We, the lookers-on, might reasonably be sceptical, might wonder what the nose had to do with it, might suspect there was some collusion between the smeller and the man who knew which liquid was which. Twenty plausible hypotheses on an assumption that the smeller was tricking us in some way might be invented, yet the simpler explanation that the man possessed a gift which we lacked would be considered revolutionary, or, indeed, might never occur to anyone at all.

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Telepathy or thought-transference is another subject concerning the genuineness of which there is often fierce discussion. Many physiologists and psychologists do not believe in it at all. Many, however, regard it as one of the functions of the unconscious mind. Freud and several other workers of importance ignore its existence, but there seems no escape from the view that it occupies a small but not unimportant place in the list of functions of the unconscious mind. A simple but illuminating description of telepathic power is given by Dr. Paul Bousfield of Harley Street in his recent book.[1]

* * * * *

"I am fortunate in possessing a friend who has developed telepathic powers to a considerable degree, and from boyhood upwards my relatives and I have had every opportunity of testing his powers under our own conditions. We have grown to look upon his powers as something more or less ordinary, and indeed have devised a new drawing-room game based upon them. I wish to give here one or two of the experiments which have taken place, not once only but very many times. In the following paragraphs I refer to him as Mr. X.

* * * * *

"Mr. X. is sent into an adjoining room quite out of earshot,[1] while we then decide upon some trivial action which he shall perform, such as picking up the poker and carrying it across the room and presenting it to Mrs. B. Mr. X., blindfolded, is now called into the room. Nobody touches him. Everyone sits perfectly quiet, no sound or word of any kind is spoken. Those sitting in the room now 'will' his *movements*, i.e. first that he shall walk to the right spot where lies the poker, then that he shall stoop, then stretch out his arm in the right direction, and so forth. As a rule, with very little hesitation, the whole performance is gone through without a hitch. Such experiments, however, must be fairly simple in character; thus, while we can make Mr. X. walk to the piano, open it and sit down, we have never succeeded in conveying to his mind a particular tune which we wish him to play. During these experiments he describes his own part as consisting in 'making his mind a blank' and moving as if under compulsion. As the sitters are not always the same on all occasions, there is no possibility of any system of signs.

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"A variant of this experiment is as follows: two groups of persons are formed. One group settles upon one set of actions, say, that Mr. X. shall take the poker and present it to Mrs. B. The other group selects a different set of actions—perhaps that he shall remove a hairpin from the head of Mrs. C. and place it on a given chair. When Mr. X. comes in a contest thus takes place. Perhaps, after a pause, the concentrated efforts of the first group succeed in getting him to pick up the poker. There may be then a feeling of triumph and relief in that group, with a consequent momentary relaxation of concentration. Immediately this takes place Mr. X. will perform part of the plan formed by the second group; he will rush to the chair and place the poker on the chair where the hairpin should have been placed. A variety of similar experiments have taken place.

* * * * *

"Perhaps the most convincing and at the same time one of the simplest experiments is as follows, and it is one which absolutely prevents any trickery

[1] *The Elements of Practical Psycho-Analysis.* By Paul Bousfield, M.R.C.S., L.R.C.P. (Kegan Paul, 10*s.* 6*d.*)

[1] An ingenious explanation of telepathy in a case like this is that the man outside really, but unconsciously, hears what those inside are saying.

whatsoever. Mr. X. sits in a chair with his back to me (or any suitable person); he is at one side of a room and I am at the other. There need be no other person in the room. I take a pack of cards, shuffle it, look at one card, concentrate my mind upon it, and say simply the one word 'Now!' Mr. X. at the other side of the room, with his back to me (or blindfolded) names the card in detail, thus, 'Queen of Hearts.' And so we proceed through the whole pack. The only word spoken is 'Now!' Mr. X. never gets all the cards right; frequently there are mistakes, but the majority of the cards are named correctly. To anyone who has performed such experiments as these, time after time, there can be no doubt about the existence of telepathy, and that it merits a place in the functions of the unconscious mind . . . its exact method of action is as yet veiled from us."

* * * * *

With his pilot-house windows screened by heavy canvas which effectively shut out the surrounding view, Commander Norton of the *Semmes*, guided only by the sound from electric waves thrown out by a submerged cable, recently piloted his vessel from near the Ambrose Lighthouse for sixteen miles along the Channel of New York Harbour to Fort Lafayette in the Narrows. The feat marked a successful test of an invention by which it is hoped to enable liners and warships to make their way into harbour to their Hudson or East River docks or anchorage, in defiance of the densest fog or the darkest nights made darker by falling snow.

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No better time for the experiment could have been hit upon, as the importance of the invention is impressed on shipping men and landsmen alike by the fact that recently the Atlantic Fleet was held up for three days outside Sandy Hook by a fog, which also delayed Transatlantic liners for a considerable time. The cable at the bottom of the fairway was charged from the fort. Two electric coils had been set above the water-line of the *Semmes* on each side of the bow, and wires extended from them into an amplifier on the bridge. From the amplifier, telephone receivers had been carried to various parts of the vessel, and with these clamped to their ears several persons were able to hear the sounds given by the cables.

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As the destroyer approached the latter at a sixteen knot speed a faint clicking of the code word "Navy" was heard. It grew louder first on the port side and then on the starboard side as the vessel steered to left or right of the cable, and Commander Norton had no trouble in following the line through the sounds, which increased in volume or grew fainter according to whether the *Semmes* was headed along it or from it.

The Ambrose Channel is 700 yards inside, but in places the shores are as much as 5,000 yards apart, so that in foggy weather a large vessel risks going aground if it ventures to thread the fairway. It is understood that the invention will be recommended for adoption, and that the Navy will lay similar cables in other harbour entrances, afterwards turning them over to the lighthouse service. It is estimated that the cable will save thousands of pounds now caused by delays to shipping through weather conditions.

Land and Sea in Greek Life—II

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool

(*Continued from the January No., p.* 18)

In the first part of this paper we noticed how the ancestors of the Greeks ceased to be a pastoral and became an agricultural people. They ceased to reckon their wealth in oxen, and assessed their incomes in bushels of produce. Their diet underwent a corresponding change. The Homeric chieftains ate large quantities of meat, but the Greeks of historical times lived almost entirely upon cereals, vegetables, and fish. Meat was only eaten when there was a sacrifice; and when Xenophon's men, marching through the desert to Cunaxa,[1] were obliged for lack of other food to adopt a meat diet, they grumbled at what they felt to be a serious hardship. But though Greece is emphatically not a land of pasture, neither is it naturally a corn-producing country.[2] The area of arable land in its little plains is very limited; above the limestone there is but a shallow layer of soil at best, and this is light and stony and yields but a poor return. In consequence, when the adoption of a peaceful settled existence resulted in a rapidly increasing population, there was soon no longer sufficient land for everyone to be a farmer; and, more serious still, the land belonging to the community no longer produced sufficient corn to feed all its members. Two obvious solutions of the economic problem suggest themselves at once: either the area of the land of the community must be

[1] 401 B.C.

[2] Baedeker's statistics for Modern Greece (1909) give 8 per cent. pasture, 18 per cent. arable, 9 per cent. forest, 65 per cent. mountain land. The area of forest was larger in antiquity, and deforestation has no doubt assisted erosion and diminished the rainfall.

increased or the number of mouths decreased. Sparta, like Rome, solved the problem in part by the conquest of more land, but it is obvious that this solution is not universally possible, for the area of land belonging to one community can only be increased at the expense of another. The second alternative was therefore widely adopted, and overpopulation made the Greeks into sailors and colonisers. Some, like the mountaineers of Arcadia, went off to serve abroad as mercenaries. As early as the seventh century B.C. Ionian and Carian mercenaries were the deciding factor in the Egyptian revolution, which threw off the Assyrian yoke and put Psammetichus I on the throne. Greek merchants went wherever there was hope of gain, and Psammetichus' soldiers were followed by the merchants of Naucratis, the Shanghai of Egypt. When Cambyses invaded Egypt in 525 B.C., Greek merchants were among his camp followers. In Herodotus' day the Greek was ubiquitous, and throughout the Oriental lands in which the historian so widely travelled, he was clearly never at a loss for an interpreter. And besides this dispersion by the emigration of individuals, there were the organised settlements sent out by the Greek States of Asia and the Balkan Peninsula. Greek colonies spread all round the Mediterranean from the Black Sea to Marseilles until, as Cicero expressed it, the world had a Greek fringe.

But even with a diminished number of mouths there was not enough corn to feed the Greeks who stayed at home; and of course the development of commerce implies the growth of a non-farming population for which provision must be made. It was inevitable, therefore, that the Greeks should become dependent upon imported corn. For this they made the necessary payment partly by the profits of the carrying trade, and partly by the export of manufactures or commodities for the production of which their country was economically suitable. The most valuable of agricultural gifts was that of Athena, the goddess of the olive. The olive thrives in the poor soil of Greece, and demands comparatively little care. Its product was indispensable in ancient life, for olive oil took the place of our butter, soap, and illuminants. Even the refuse after the oil has been squeezed was valuable then, as now, for cattle food. There is no waste about the olive. The vine, too, can be grown with profit, particularly in the volcanic soil of the islands. Malvoisie derived its name from a district in Crete, and Modern Europe drinks more Greek wine than perhaps it knows.

The natural tendency, then, is for the Greeks to develop the culture of the vine and olive, and to pay for imported corn with the profits of the export of wine and oil. But if you are sending wine and oil by freight a receptacle is necessary, and in consequence the export of these goods tended to stimulate the pottery-industry. Of course cargo in bulk was not sent in the highly decorated painted ware, but in big Ali Baba jars. It can hardly be doubted, however, that the pottery trade as a whole received a stimulus. The finely painted wares were destined mainly for the Etruscan market, to be used as funerary furniture in the tombs of the wealthy; but Herodotus tells us rather an interesting thing about the wine jars. A large number of jars of Greek wine were yearly imported by Egypt. Of these the "empties" were collected, and were used on the waterless caravan route through the eastern desert to form artificial water depots.

The conditions of early navigation were difficult,

MELOS. LIMESTONE AND SCRUB; SHOWING THE POOR NATURE OF THE SOIL.

although Nature, as we have seen, had provided exceptional facilities in the chains of islands which gave both shelter and guidance to the early mariner. Old Hesiod knows the rules for seafaring, but is not very enthusiastic about it as a profession. It is too chancy and the risk is too great. His advice, however, to the young adventurer, who refuses to be warned off, is perfectly sound; his rules as to seasons hold good to-day, and could be illustrated from the weekly statistics of the movements of sailing vessels, which it was lately my duty to collect and send to Mudros. There are two seasons when sailing is possible. In the summer there is nothing to fear except squalls, and the prevailing wind is northerly. For the Etesian winds not only cool the torrid heat, but provide a steady trade-wind, and Plato has described how with their advent come the merchants "flying over sea in spring-

time like birds of passage to all foreign countries." The early spring season is much less reliable; heavy gales occur and the adventurer may suffer shipwreck. The worst time of all is the autumn, when the rains begin. Then you must avoid lingering at sea, or you may suffer like St. Paul. The winter was a close time for navigation; ships were hauled up and the tackle stored by the fire. This seasonal limitation

A VIEW OF THE COAST: CLIFFS AND SCRUB ON THE WEST SIDE OF CORFU.

remained a characteristic of navigation in classical times. When Julius Cæsar, after the defeat of Pompey, became involved in Egypt in 48 B.C., no news of him was received in Rome throughout the winter. And here a small point may be noticed. Many of the Greek harbours point south and are exposed to southerly gales (e.g. the harbour of ancient Samos). Southerly gales, however, are mainly to be feared in the winter, when the ships in ancient times were safely hauled up upon terra firma. Short of beaching his ship for the winter, the skipper of St. Paul's vessel had no choice of remaining in "the Fair Havens." It is an admirable little harbour for a small vessel (as upon one occasion at least a U-boat commander appreciated) when the wind is in another quarter, but its mouth lies open to the prevailing gales of winter.

Despite the difficulties of early navigation, Greek explorers persevered, and in the Eastern Mediterranean they wrested the monopoly of the carrying trade from the Phœnicians. In the west Carthage proved too strong a rival. Tartessus in Spain was sporadically visited by Æginetans, Phocæans, and Samians; but Marseilles remained the isolated western limit of Greek colonisation, and attempts to found intermediate posts were frustrated by the Carthaginian–Etruscan alliance. "The Silent Trade" of the West African coast[1] and the passage to the Tin Islands remained wholly in Carthaginian hands. The secrets of their charts were jealously guarded by the Semites, and the skippers of other nationalities whom they caught beyond the Straits of Gibraltar were made to walk the plank.

Apart from the Carthaginians, life upon the sea was pretty lawless—commerce and piracy went hand in hand. "I am the servant of the lord god of war," sang the adventurer Archilochus in the middle of the seventh century, "and I know the lovely gifts of the Muses. In my spear is kneaded bread, in my spear is wine of Ismarus, and I lie upon my spear as I drink." The merchantmen of a rival state were fair game, and competition was not restricted to peaceful rivalry. The smaller islands were nests of wreckers, and the tale of wrecking goes back to the legendary times of the return from Troy, when Nauplius lured the Greeks upon the rocks by means of misleading flares.

The disorder upon the high seas was naturally increased by the Persian conquest of the Greeks of Asia in the sixth century. Refugees and desperate exiles were driven to homeless wandering or preferred the freedom of adventure to the burden of a foreign yoke. For this ferment the Western Mediterranean provided to some extent a safety-valve, and Greek adventurers in Carthaginian waters played a rôle comparable to that of our Elizabethan sailors in the Spanish Main. That stout sea captain, Dionysius the Phocæan, when, thanks to divided leadership and the desertion of traitors, the cause of the Ionian rebels was irretrievably lost at Lade in 494, escaped with the ships under his command, and after a raid upon Phœnician shipping in the Levant, established himself in Sicilian waters as a patriotic pirate, plundering Carthaginians and Etruscans, but not his own countrymen.

The Mediterranean, indeed, with its numerous islands, has always been a prey to piracy. Whatever the political shortcomings of Athenian imperialism, the Athenian Empire conferred no small material benefit upon Greek commerce as a whole by effectively policing the seas and suppressing, as at Scyros in 474, the pirate strongholds. For up to the nineteenth century there have been but two periods when the sea routes of the

[1] Herodotus (iv. 196) describes, but from hearsay only, how the Carthaginian merchants laid their goods upon the beach and re-embarked after making a smoke signal. The natives then laid gold beside the goods and retired. If the Carthaginians did not think it sufficient, they returned again to their ships and remained at anchor while the natives added to the gold. When a fair price was reached the Carthaginians took the gold, left the goods, and sailed away. This method of silent trading finds analogies to-day; see, for instance, the account of the barter between the Hawai-u and Kuku-kuku peoples in the Official Report for Papua, 1907 (Report of H. L. Griffin, R.M. Gulf Division).

Eastern Mediterranean have been free from pirates: the first half of the fifth century under the rule of Athens, and under Roman rule, after Pompey had cleared the seas in 67 B.C. And to-day the same phenomenon may be remarked which Thucydides noticed in the fifth century. Before his time, he tells us, the coastal towns, for fear of pirates, were built not at the harbour's edge, but upon the hills behind; but since the Athenian Empire had restored security, the towns were creeping down to the obvious convenience of the water's edge. In mediæval times insecurity once more drove the villages to the hills, and it is only in the nineteenth century that peace upon the high seas once more permitted them to leave "the Castro" for the harbour. The port of Syra provides a good example. The older villages crown the twin hills behind the harbour, and every building in the modern port, which has grown up at the water's edge, is subsequent in date to the liberation of Greece.[1]

In the fifth century B.C. Athens became the central mart of the world's trade. The premier commercial powers of the sixth century had suffered from the advance of Persia, and though the states of the Asia Minor coast and islands had been "liberated," they had in fact exchanged a foreign for an Athenian yoke; while the hostile relations existing between Persia and Greece injuriously affected communities whose commercial greatness had been based upon their position at the terminal points at which the Eastern caravan routes debouched. Ionian commerce, no less than Ionian philosophy and letters, migrated in the fifth century to Athens. Ancient trade consisted principally of luxuries and necessaries; the intermediate class of goods, which may be called dispensable comforts or conveniences, and which form, I imagine, the bulk of modern commerce, was then but little in evidence. The Greek market, like Solomon's, is concerned mainly with "peacocks, apes, and ivories," or with necessaries like timber, oil, and corn, which, it will be remembered, formed the material of the Jewish king's deal with Hiram of Tyre.[2] For the merchant luxuries brought in the larger profit; the most valuable commodities, says Herodotus, inverting the true significance of the fact, are to be found in the remotest parts of the world. But from the State's point of view necessaries, which include timber, essential for a shipping power, metals, and corn, are more important. To ensure a supply and to control the distribution of vital necessaries, the State established strict control. The merchant of an Athenian vessel was compelled by law to load corn as part of his return cargo. At the Dardanelles the destination of cornships was controlled by Athenian officials, and Pontic merchants selling corn in any other market without Athenian permission were liable to the death penalty. State officials took charge of the delivery at the Piræus and regulated the distribution of supplies to retail dealers.

That Athens was right in regarding the control of the Russian corn trade of vital importance was shown by events. At the battle of Ægospotami in 405 B.C. she lost control of the Dardanelles, and her starvation automatically followed.

More profitable to the private speculator was the trade in luxuries. Carpets and embroideries from Carthage, metalware from Etruria, ivory from Africa, goodly Babylonitish garments from the East, and possibly even silk from China, found a way to the Piræus; and the peach, the pheasant, and the peacock made their appearance in Greece in the fifth century. Peacocks were first introduced by Pyrilampes, who had been an ambassador in Persia. They attracted great attention; "Is it a peacock or a bird?" asks a character in Aristophanes at a time when the novelty was in its first bloom; but even in the next generation people came from all over Greece to see them, and upon set days the aviary was thrown open to the inquisitive public.

The standard of luxury was naturally raised, and if life at the close of the century was hardly comfortable in a modern sense, it was considerably more ostentatious than at the beginning. The change, however, in the material standard of living was incommensurate with the spiritual change wrought by the expansion of commerce, and the vistas which travel and exploration opened up. We know what the discovery of America did for Europe; a similar broadening of the horizon

VIEW OF THE COUNTRYSIDE AT SUNIUM ON THE WEST SIDE OF ATTICA.

[1] Similarly in the western end of Cos the now deserted castle of the Rhodian knights at Antimachia was inhabited for security in recent times. I was assured that the modern villages in its vicinity have all come into existence since the Crimean War.

[2] 1 Kings, v.

gave new energy to Greek art and thought. Æschylus no less than Herodotus is moved by the new geography.

Travellers' tales from the ends of the world now took the place of the early sailors' yarns. Scylla was no longer to be met with round the Mediterranean coasts as in the Bronze Age or in the days of Homer.[1] But though the boundaries of the world had been pushed back, travellers had still tales to tell of their remoter edges. Above the Issedonians, Herodotus tells us simply, dwell the Arimaspians, who have only one eye, and the gryphons who guard the gold. Or, as typical of the new type of wonder-tale, take his account of cinnamon. "We Greeks," he says, "get our cinnamon from the Phœnicians, but it is originally collected by the Arabians. There is an enormous bird in Arabia, which builds its nests of mud and cinnamon logs on the tops of inaccessible precipices. The Arabians get at them in this way. They put out whole carcases of oxen, which the bird carries off to the nest; the added weight is too much for the structure; down falls the nest, and the ingenious Arabians pick up the debris. And that is how we get our cinnamon."

Neglected Aspects of Mathematics

By C. A. Stewart, M.A.

Lecturer in Mathematics in the University of Sheffield

Of those who do not understand Pure Mathematics, some are respectful as if entering a shrine; but others, of the baser sort, are contemptuous. These have found the way of progress dark and difficult. Their guides, perhaps, have not inspired them, and symbolism seems far removed from the needs of ordinary human life. They deny that it can have an ideal, that it can have any claim to beauty. They admit that it has some purpose in its application to the practical affairs of life, but that it can have an end in itself is incomprehensible. It is associated in the minds of some with the removing of interminable brackets, and with the chasing of elusive unknowns. Since it deals usually with the variable and not with the particular, and since it is concerned more with deductions from data than with the truth of these data, it has been described as the subject "in which we never know what we are talking about, nor whether what we are saying is true."[1] It is usually considered unwise to express lack of appreciation of the works of a great painter or sculptor or poet, but there have been men of intellect who not only have expressed ignorance of scientific method, but have also been inclined to exaggerate that ignorance. The questions that such a criticism of the subject naturally raises are: Is this hostility justified? Can it be wholly attributed to feebleness of insight? For it is possible that although Mathematics need not fail to supply the necessary stimulus to intellectual thoughts and aspirations, yet its exponents may fail in the interpretation and expression of its ideals; and it must be admitted that the way of mathematical learning can be, and often is, a dull and cheerless one, especially for him whose aptitude is weak. The inherent beauty of mathematical reasoning may be marred by methods that are brutal, and its outlook warped by unduly insisting on the necessity of the moment.

My object in this article is to consider the position of the mathematician in two of his possible moods—during his moments of leisure and during his moments of reflection. Are there pleasant bypaths of mathematical thought and speculation for him to wander in during his hour of freedom? Are there fields of activity within its sphere that can fitly be described as inherently attractive? And is there scope in mathematical teaching for the occasional introduction of what is distinctly recreative or amusing? He has, too, his moments of weakness, his hours of doubt, when he is oppressed by the feebleness of his efforts, the apparent uselessness of all his endeavour and the emptiness of his outlook. Is there sufficient purpose in what mathematicians have achieved to provide him solace at these times? Has the use of Mathematics been so beneficial in the interests of humanity as to strengthen him in the continuation of his task? It is then that his mind becomes receptive of a higher conception of his subject. In contemplating its strength and greatness, its permanence and beauty, he recognises that it has defined his attitude to the world and has guided him in the art of living.

This, then, is the first consideration: Is Mathematics interesting or not?—one not unimportant in the view of the modern trend of educational method. Can the subject be made attractive not merely to those who

[1] Homer, *Odyssey*, ix–xii, with its cannibals, sirens, clashing rocks, and the western end of the world where dwell the dead, is a collection of sailors' yarns. In a narrow strait between two cliffs on the one hand was a whirlpool, and on the other a sheer precipice halfway up which was a hole so deep and high that an arrow would not reach. Here lurked Scylla. "Her voice, indeed, is no greater than the voice of a new-born puppy, but a dreadful monster is she, nor would any look on her gladly, not if he were a god that met her. Verily she hath twelve feet all dangling down, and six necks exceeding long, and on each a hideous head, and therein three rows of teeth set thick and close full of black death. Up to her middle is she sunk far down in the hollow cave, but forth she holds her heads from the dreadful gulf, and there she fishes, swooping down from the rock for dolphin or sea-dogs, or whatsogreater beast she may anywhere take." Sir Arthur Evans has published a clay sealing of the Bronze Age which depicts a man in a boat being attacked by a dog-headed sea-monster. *Journal of Hellenic Studies*, xxxii, p. 291.

[1] Bertrand Russell, *Mathematics and Metaphysics*.

have the natural aptitude, but also to that greater number who apparently use it as a means towards an end? The justification of the introduction of any element that will have the tendency to drive away monotony is apparent when we consider how progress is dependent on the awakening and the maintaining of interest.

It is naturally impossible for me to attempt a detailed exposition of the recreative aspect of mathematical work; and so I must be content to give a brief survey of the subject from this point of view, to make a short reference to one or two of the suggestions that will have been made, and to make one theme the chief illustration. Mathematics is particularly fortunate in possessing a wide field from which to select work of this description, the following being some of the possibilities: Recreations, Arithmetical, Geometrical, and Mechanical; Practical Mathematics; its uses in such spheres as business, sport, or war; its applications to other sciences; its history, not only of individuals, but of the problems that have been handed down from the past; and, lastly, a more recondite subject, hardly suitable for the immature—I mean the study of its fundamental notions, a study that is necessary for obtaining a true conception of its ideals and infinite possibilities.

There are three facts in the modern history of Mathematics that show a tendency in the direction of which I am speaking—a tendency towards the lightening of the burden of the mathematical pupil. The first is the use of Analytical methods, which became universal in England about ninety years ago; the other two, of comparatively recent date, are the superseding of Euclid and the introduction of Practical Mathematics. The treatment that has replaced Euclid is open to innumerable objections, but it still remains a step in the right direction, and was taken on the Continent long before we thought about it. The deadening influence on the youthful mind of abstract methods of exposition is further mitigated by the introduction of Practical Mathematics; and it is therefore not unreasonable to suppose that this subject, which is in its infancy, will in future include sections not hitherto contemplated.

This naturally leads us on to think of the interesting story of the applications of Mathematics to other sciences and to the ordinary business of life. Much of it is known, at least vaguely, to most people, and it is unnecessary here to illustrate what is common knowledge. It is difficult, however, to think of the subject at all without at least referring to the remarkable work of that illustrious mathematician and physicist, James Clerk Maxwell. But rather than give positive instances of the extensive use of mathematical results, I venture to describe an incident from the late war to show the kind of situation that arises when the application of a mathematical idea is entrusted to the uninitiated. In the schools of instruction established for officers, many of the classes were, as is well known, conducted by sergeants of the regular army. These instructors were efficient in many ways, but it would be an exaggeration to say that their knowledge of science was profound. One of them I know of was explaining to a class of Artillery officers how the angle of elevation of a gun was measured, and in the course of his argument made the statement that the diameter of a circle went exactly three times into the circumference. One of his audience was dubious of this, and asked him if that was quite accurate. "Was there not a little bit left over when the division was made?" This made the instructor shaky of his position, and he said he would get the sergeant-major to explain. This particular sergeant-major had the reputation of being omniscient; and, in any case, being a sergeant-major, was never at loss for a reply. He came over to the class and said he would explain how it was that the diameter went into the circumference exactly three times. Taking a penny from his pocket and holding it up, he said, "Look at the little circle formed by this penny. If you were to measure the diameter and then the circumference, you would find that the one was three times the other." "But, of course," he added disdainfully, making a large sweeping movement with his hands, "if you had a *big* circle, anything might happen."

Some people are above Mathematical recreations, but when we remember that in most of us there is something imaginative, something of the spirit of emulation, we can afford to ignore their views. Some would say that recreations are too trivial to deserve serious thought, but what has been the study of men like Euler, Fermat, and Legendre, we cannot affect to despise. Liebnitz in one of his letters remarked[1] that men were never more ingenious than in the invention of games; here the mind was at ease; after games that depended solely on numbers came those of position; and after those, where only number and position appeared, came the games that involved motion; that one would, in fact, desire to have a course of study, entirely devoted to games treated mathematically.

A typical arithmetical fallacy is one dependent on the ambiguity of the root sign. For example, we may express the identity

$$\sqrt{-1} = \sqrt{-1}$$

in the form

$$\sqrt{\frac{-1}{1}} = \sqrt{\frac{1}{-1}}$$

and therefore

$$\frac{\sqrt{-1}}{\sqrt{1}} = \frac{\sqrt{1}}{\sqrt{-1}}$$

hence $(\sqrt{-1})^2 = (\sqrt{1})^2$ on multiplying across

$$\therefore -1 = 1.$$

[1] Quoted by W. W. Rouse Ball in *Mathematical Recreations*, 1919. (Macmillan, 12*s*. 6*d*.)

There is an excellent problem, neither a catch nor a fallacy, but really perfectly straightforward, which a reader may successfully try on his friends—if they have not heard of it previously. It illustrates the well-known fact that an arithmetical problem is frequently not just what one may hastily suppose. The problem is this:

A man is engaged at a salary which commences at the rate of (say) £400 per annum, and is asked which he will prefer, a yearly rise of £40 or a half-yearly rise not of £20, but of £10. Which should he select?

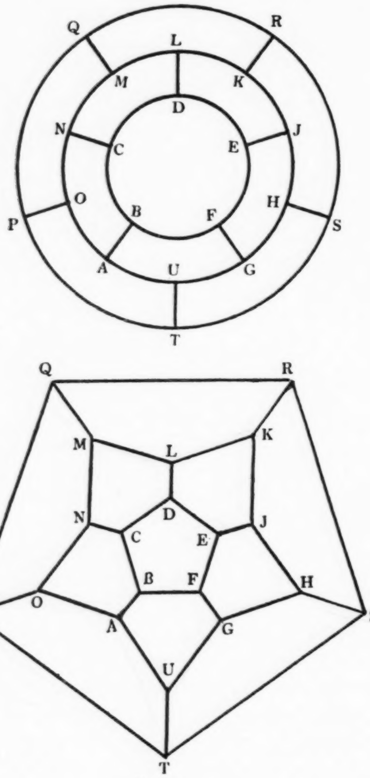


FIG. 1.

Most people will say at once, the former; but they are wrong. For with the first choice the man would receive £400 in the first year, and with the second choice £200 + £210. He has thus £10 more at the end of his first year. During the second year his first choice would give him £440, his second choice £220 + £230. Again he has £10 more, and this continues each year.

Geometrical recreations consist chiefly of fallacies, paradoxes, and games of position, and it will be sufficient for me to illustrate them by taking a typical example of the latter known as the Hamiltonian Game.[1]

[1] W. W. Rouse Ball in *Mathematical Recreations*, 1919, p. 189.

This game was invented by Sir William Hamilton, and consists in the determination of a route along the edges of a regular dodecahedron which will pass once and once only through every angular point. As a dodecahedron is a solid figure, it is consequently difficult to use for this game, and for the purposes of solution the solid may be conveniently represented by either of the diagrams of Fig. 1.

To make the problem really a game, Hamilton gave each point lettered in the diagram the name of a town, so that the game consists in starting at any town and going "all round the world," visiting every town once only, and ending up at the point of departure. The game is varied by compelling the solver to visit certain towns in a certain order first before going on to the others. Not more than five towns should be included in this restriction.

The problem is attacked in the following way: At each angular point there are three edges (three lines in the diagram). As we approach a point there are only two routes open to us after passing it—the one leading to the right is denoted by r, that to the left by l. If we go to the left; then, after passing a town, to the right; then, after passing a second town, to the left, we denote the operation by lrl; twice to the left and once to the right by l^2r, and so on. Five times in succession to the left, or to the right brings us back to where we started. These facts may be represented by the equations $l^5 = 1$, $r^5 = 1$. It will also be found from the figure that the following pairs of journeys lead to the same place: lr^2l and rlr; rl^2r and lrl; lr^3l and r^2; rl^3r and l^2.

Now, in our problem we have to move through twenty points, ending up where we began. There are thus twenty successive operations, the total effect of which is equal to unity. We have, therefore, to find an expression which has twenty terms in r and l which will be equal to unity. This expression is obtained thus: By making repeated use of the relation $l^2 = rl^3r$ we find that

$$1 = l^5 = l^2l^3 = rl^3r\,l^3 = (rl^3)^2 = \{r(rl^3r)l\}^2$$
$$= \{r^2\,l^3\,rl\}^2 = \{r^2\,rl^3r\,lrl\}^2 = \{r^3\,l^3\,rlrl\}^2$$
$$\therefore \{r^3\,l^3\,(rl)^2\}^2 = 1.$$
$$\text{Similarly } \{l^3\,r^3\,(lr)^2\}^2 = 1.$$

Each of these has twenty terms.

Hence to go "all round the world" our directions are:

r r r l l l r l r l r r r l l l r l r l,

or

l l l r r r l r l r l l l r r r l r l r.

The first set of directions means "go to the right till the next town is reached, then go again to the right till the next town is reached, then again to the right, then to the left, to the left again, etc.," and similarly for the second.

It should be pointed out that one may commence at any point in the series of operations by transferring the proper number of letters from one end to the other. Thus, suppose we choose to commence with the ninth direction of the first series, the new series of directions would be:

rlrrrlllrlrlrrrlllrl,

or if we commenced with (say) the eighth of the second series, the new series would run:

rlrlllrrrlrlrlllrrrl.

The particular direction we commence off with is fixed by the order of certain towns which we must visit initially.

Suppose, for example, we are told to start at S (see the figure), proceed to H, then to J, then to E, then to D, and then to go once through all the other towns, and return to S. From S to H is either *l* or *r* depending upon whether we got to S from T or R. From H to J is *r*, J to E is *l*, E to D is *r*. Our directions initially are, therefore, either *lrlr* or *rrlr*. The first of these combinations occurs in the First Series and the second in the Second. The solutions are, therefore,

lrlrrrlllrlrlrrrlllr

and

rrlrlrlllrrrlrlrlllr,

and the orders of the towns visited are respectively

S, H, J, E, D, L, K, R, Q, M, N, C, B, F, G, U, A, O, P, T, S

and

S, H, J, E, D, C, N, O, A, B, F, G, U, T, P, Q, M, L, K, R, S.

Mr. Rouse Ball, who describes this game in detail, recommends the solver, for convenience and to prevent error, to make a mark at, or put down a counter on, each town as it is reached.

A geometrical problem of a simpler and better-known kind is the "proof" by dissection that 65 = 64. If the square of side 8 in Fig. 2 be cut along the lines indicated, it may be fitted into a parallelogram whose sides are 13 and 5.

The paradox depends upon the relation

$$5 \times 13 - 8^2 = 1$$

and the fallacy lies in the fact that the four pieces of the cut-up square, when fitted together, do not really make a parallelogram. There is a small diamond-shaped space, the area of which is 1, which is apt to be overlooked unless the cutting-up and the fitting together be very accurately carried out.

A square of side 21 may be similarly cut up and fitted together to form a parallelogram of sides 13 and 34; and one of side 55 to form a parallelogram of sides 34 and 89.

The subject of Arithmetical recreations forms part of a section of mathematical work which is sometimes regarded as special in character, but whose results permeate the whole of Mathematical study. The Theory of Number is full of paradox and mystery, treating of entities apparently simple in character, but really so complex as to provoke everlasting discussion. Number is the root of all mathematical evil; it is the source of much mathematical pleasure. The study of its true significance has traditionally belonged to abstract philosophy, but now the mathematician can give the more adequate interpretation. The processes of counting and tallying are amongst the first activities of human intelligence; and the problems that arise in connection therewith form the subject-matter of the most recent mathematical research. Its domain is vast. A true conception of its nature is fundamental to analysis, and the modern theory corresponds in a

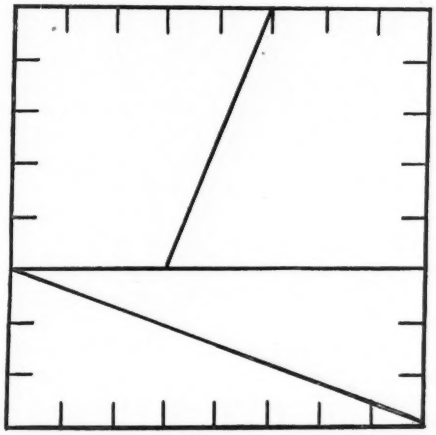


FIG. 2.

remarkable way to the traditional and empirical notions of spatial magnitude.

Positive numbers present themselves in a dense array stretching from the infinite to the infinitesimal. Imagine them arrayed in order of magnitude as we do when we represent them by points on a line. They are so dense that an infinity of them exists between any two of them, however near. But of this vast aggregate certain numbers stand out with great prominence, possessing properties of a special and often mysterious nature. They are human in some of their attributes, for some are perfect and some are amicable; some lucky and some unlucky. One investigator who spent the greater part of his life in studying them became so familiar with them that he was said to regard each positive integer as a personal friend.[1] Although this class of positive integers forms the subject-matter of a theory by itself, the interesting fact in connection with them

[1] Prof. G. H. Hardy, *Some Famous Problems of the Theory of Numbers*, 1920.

is that the solution of many of its classical problems is intimately associated with the theory of functions of continuous magnitude. One feature that distinguishes it from most of the other branches of Mathematics is the comparative simplicity with which its problems can be stated; not merely the easier problems, but even those that have hitherto defied solution. For example: What is the minimum number of squares which, when added together, will equal any given number? What is the number of primes less than n? Goldbach's Theorem that every even number is the sum of two primes. Waring's general problem and the theory of Mersenne's numbers; and the famous last theorem of Fermat that $x^n + y^n = z^n$ has no solution in positive integers if n is greater than 2.

More detailed mention may be made of one of these.[1] In 1644 Mersenne published a book in which he asserted that, in order that $2^p - 1$ may be a prime number, the only values of p, not greater than 257, which are possible are 1, 2, 3, 5, 7, 13, 17, 19, 31, 67, 127, and 257; 61 has since been added to this list. To confirm Mersenne's statement is an extremely laborious undertaking, and it has been tested in a few cases only, but so far as we know at present the statement is true. The number $2^{61} - 1$ is the highest prime number at present known. Evaluated it is 2,305,843,009,213,693,951. The expression $2^{p-1}(2^p - 1)$ where $2^p - 1$ is a prime number is considered to include all perfect numbers. A number is said to be perfect if it is equal to the sum of all its integral subdivisors. 28, for example, is a perfect number because its divisors 1, 2, 4, 7, and 14, add up to 28, so is 6, so is 496. It is considered that *every* perfect number must be expressible in the form given above, because the expression has been shown by Euler to include all *even* perfect numbers, and it is believed that an *odd* number cannot be perfect.

Now, the prime numbers represented by the expression $2^p - 1$ are known from Mersenne's work. Thus, if $p = 2$, the corresponding prime number is $2^2 - 1$, i.e. 3, and the corresponding perfect number is 2^{2-1}
6 $(2^2 - 1)$, i.e. ~~4~~. If $p = 3$, the corresponding prime number is similarly 7, and the corresponding perfect number is 28. If $p = 5$, the prime number is 31, the perfect number 496. If $p = 7$, the prime number is 127, and the perfect number 8,128. As the values of p increase, the prime and perfect numbers increase alarmingly. Thus, if $p = 61$, the prime number corresponding is 2,147,483,647, and the perfect number 2,305,843,008,139,952,128. It would be rather a long and difficult task to factorise this last number and show that the sum of the factors is equal to itself!

This simplicity in subject-matter makes it a fruitful field for mathematical recreation. The problems are numerous, and many of them may be found in the well-known work of Mr. W. W. Rouse Ball. The questions that arise may be trivial or important; they may make problems of a day or problems for all time. There is a game which may sometimes be seen played for high stakes in the smoke-room of an Atlantic liner, and which may serve as an illustration of the former type. It has the appearance of being solely dependent on the chance arrangements of the numbers concerned, but in reality an expert can nearly always beat an unskilful opponent. The contents of a box of matches are divided at random into three heaps. The rule of the game is that the one whose turn it is to play may take *one* or *all* from any heap, but he must not touch more than one heap. The loser is the one who is forced to take the last match. If, for example, after several moves, a player leaves his opponent 1 : 1 : 1, he must win, for his opponent is forced to take the last match. Again, if he leaves 1 : 2 : 3, it is not difficult to see that he can also force a win. The method of the expert is to remember certain key-numbers which will force a win from the initial outlay. The solution of the problem of finding these key-numbers has been given in an American journal,[1] and is very ingenious. It consists in expressing the numbers in each heap in the binary scale. (On the binary scale, 1 is represented by 1, 2 by 10, 3 by 11, 4 by 100, 5 by 101, 6 by 110, 7 by 111, 8 by 1,000, 9 by 1,001, 10 by 1,010, 11 by 1,011, 12 by 1,100, 13 by 1,101, 14 by 1,110, 15 by 1,111, 16 by 10,000, and so on. See *Scales of Notation* in an Arithmetic Book.) If the sums of the corresponding digits are *all* even, the outlay forms a key-number. By corresponding digits are meant all the digits at the right of the numbers, or all those second from the right; or all those third from the right, and so on. If some are odd, it can be so altered according to the rules to form the required combination. For example, if the initial outlay were 8 : 7 : 9, these numbers in the binary scale are 1,000 : 111 : 1,001. The sums of the corresponding digits are 2, 1, 1, 2. It is, therefore, not a key-number, but can be made one by removing the two 1's, i.e. by changing the middle heap to 1. A little experience both in the theory of this problem and in its practice will make one an expert in it.

The above example illustrates the recreative aspect of number, but gives no indication of the vast number of ingenious problems and games of skill that have been devised. The more serious types of problems may not always be justly termed recreative, but they certainly can be described as interesting. They are characterised by their age and historical connections, by the simplicity of their statements and by their intractability. This is sufficient to command the attention and interest of even the immature, and it would not be ridiculous to imagine a schoolboy making a praiseworthy attempt

[1] This is taken from Mr. Rouse Ball's book.

[2] W. W. Rouse Ball, *Mathematical Recreations*, p. 21.

at the solution of Fermat's last theorem. There is probably no other branch of scientific work where such a remark would apply. The fact that a great deal of recent mathematical research has been concentrated in this direction is an item of additional interest. Progress is being made in two main classes of problems —in the theory of partitions and in the theory of the distribution of primes. In both of these is seen the same fundamental characteristic—the intense difficulty of the analysis combined with the remarkable simplicity of the results aimed at. It is comparatively simple to enunciate the problem: In how many ways is it possible to express a number n as the sum of other numbers less than n?—but its solution requires the discussion of an elliptic modular function. It is suggested, then, not that the methods here are simple, but that the results achieved and contemplated are in many cases within the comprehension of those of moderate attainments.

The positive integers, however, form only a very small class of the numbers that exist. The theory of rational and irrational numbers brings problems to our notice of a totally different character. It is here that the mathematician has entered the realm of the philosopher, and has seized territory from which it will be difficult to dislodge him. The problems of the infinite and the infinitesimal have been inadequately represented since Zeno first propounded them in his famous paradoxes. The great Eleatic, unconscious of the false premises latent in his mind, obtained results inconsistent with experience. A strict investigation into the nature of the mathematical infinite, effectively conpleted by the mathematician, is necessary for the solution of the paradoxes. The fallacy is now seen to consist in applying the properties of finite aggregates to the infinite. That the whole is greater than its part, or that a number can be obtained by the process of counting, seem self-evident statements, but they produce disastrous results when applied to the infinite. The accurate theory of the irrational and of the infinite, first propounded by Dedekind and Cantor about fifty years ago, gives rise to many interesting speculations. What, for example, is the correspondence between a set of points and the continuum of real number? Are all infinite numbers equal? Is there a greatest number? It seems natural to suppose that there must be, namely the number that includes everything, but Cantor proves that it does not exist.

From such speculations the mind naturally passes to the consideration of the general philosophy of Mathematical thought: its purpose and ideals. Its value in a technical education will be revealed by its usefulness, but its ideals alone measure its value in a liberal education. The Professor of Mathematics at Oxford said quite recently that the life of a mathematician was possibly one which no perfectly reasonable man would elect to live, and that "it is something to be able to say that at any rate we do no harm."[1] There is a chance of such a remark being taken more seriously than was intended, for there is a tendency for the mathematician to concede all that is artistic to the classical and literary scholar. He is apt to think that its manifold uses in the practical life are sufficient to compensate what many regard as its deficiency in culture. But there must be value in a study that tends to regulate the mind in its outlook on life—one freed from those natural prejudices and desires that prevent a clear, uncoloured view of human conduct. The scientific method, as the Hon. Bertrand Russell has persuasively shown,[2] is free from the disturbing influence of ethical considerations, and might be oftener used in other branches of thought. There have been instances even in the history of science itself where progress has been hindered by the introduction of ethical and religious beliefs. To believe that the earth went round the sun was to show the greatest irreverence, this being inconsistent with the theory, so comforting to human egoism, that the earth was the centre of the universe. The classicist and literary scholar, we are often told, lives in the past, and when contemplating the things of the present, will exclaim in the words of the Ecclesiast, "There is nothing new under the sun." Talk to him of some event in modern history, and he will give you a quotation from the austere historian of Greece, describing an exact parallel in the Peloponnesian War. However that may be, the mathematician is not so encompassed by the presence of a completed system of knowledge, and consequently his endeavours are not obvious repetitions of what has already been done. It may be that the Chinese once knew of Taylor's theorem, or that the chimpanzee was once acquainted with the rule of three, but we certainly do not know these statements to be true; and we think them highly improbable. There is always, therefore, the hope of discovery of something new, and comfort in thinking of possible achievement.

In the modern striving after practical results, there is an aspect of Mathematics that is apt to be ignored. The high value with which we estimate a technical education should not detract from the æsthetic claim of Pure Mathematics based on the beauty of its pure reasoning. It is not a beauty of colour and shade; it is one of order and austerity. There is nothing incongruous in regarding as a work of art a theorem wherein is displayed a simple exposition of the necessary and sufficient.

This suggests another characteristic often absent elsewhere—the characteristic of permanence; and it

[1] *Some Famous Problems of the Theory of Numbers*, 1920.
[2] *Scientific Method in Philosophy.*

can be no mean occupation to be an artificer in an edifice the foundation-stones of which were laid before Pythagoras lived. Here there is work for the mediocre as well as the talented; as Russell puts it: "The edifice of science needs its masons, bricklayers, and common labourers as well as its foremen, master-builders, and architects. In art nothing worth doing can be done without genius; in science even a moderate capacity can contribute to a supreme achievement."[1]

The reader may study the subject further in *Mathematical Recreations and Problems*, by W. W. Rouse Ball. Eighth edition. (Macmillan, 12*s*. 6*d*.) A fascinating book.

The Rôle of Physiology[2] in National Life

By A. V. Hill, Sc.D., F.R.S.

Professor of Physiology in the University of Manchester

HITHERTO Physiology has had two rôles, that of an abstract science devoted to the elucidation of problems provided by the living creature, and that of the handmaid of medicine attempting to describe the normal healthy functions which medicine has to restore after they have gone wrong. The physiologist, therefore, had to earn a living either as a student and teacher in a university, or as a practising medical man. To these two rôles is now being added a third, which we will proceed to describe—that of a student and investigator of the human or biological factor in the social, economic, or industrial system.

It is obvious that in the last resort our political and social system rests upon the mental and bodily characteristics of its unit, MAN, and that these in the aggregate depend largely on heredity and environment, and not merely on fortuitous factors. The exact degree to which the behaviour and the bodily, mental, and moral "fitness" of men depend upon environment and heredity is not yet known, possibly not knowable: it is certain, however, that, within limits, "fitness" and efficiency depend upon adequate training and nutrition, and mental, moral, and bodily health on heredity and example as well as on environment. Further, it is obvious that a man's natural powers fit him usually more for one trade than another, and that it ought to be possible often to state in precise terms what that trade should be. Hitherto selection, both in national and in individual life, has been left to nature, and man has progressed slowly and unconsciously towards an unknown goal. Recently, however, he has taken upon himself so largely to control, by understanding, the forces of nature, that a whole new crop of problems is springing up insistently around him. Large urban populations have arisen as a result of the conquests of hygiene and engineering; plagues have been abolished by the discoveries of medicine; famines have been mitigated by facility of transport, and highly skilled and specialised trades have arisen calling for a new type of average man. Moreover, the coming of some degree of general education and self-government, together with the growth of class consciousness and nationalism, have made it necessary to exercise the utmost care in the applications of the science of man as a biological unit. These applications, however, are bound to come: man has taken upon himself to prevent plagues and to mitigate famines, and he will shortly have to limit population, to improve industrial efficiency and to eliminate waste—or a worse thing will befall him. All men get sick and die, and so all pass within the purview of medicine: this is inevitable, and there is little prejudice against regarding the sick man as the "material" of medical science. But many men, for the larger part of their lives, are normal healthy individuals; many others would have been healthy had we made an adequate study of the conditions required to maintain their efficiency in the state of life to which they have been called. These men require, not medicine, but physiology, to discover, develop and utilise their normal powers and functions to the full, and to see that the lives they lead are of the greatest benefit to themselves, to their neighbours, and to their descendants.

Nutrition, hours of work, standards of physical and mental fitness of different types of population, recreations, physical training, vocational training, standards of living, the effect of various habits and propensities on the normal man, eugenics and what to breed for if we could, these are among the many points at which the economic and social problem touches on the biological one. Physiology as yet can give no answer to these problems, partly because of their inherent difficulty, but largely because she has tended, with Medicine, to regard the human factor from the bedside. It is necessary to found a new profession, that of Physiology, charged with the study of the biological factor in normal human affairs.

To take an example from the more purely physiological side, the investigations of J. S. Haldane on the respiratory conditions in mines, the experiments by Hopkins on "accessory factors" in food, or the work of the Anthropometric Standards Committee of the Medical Research Council, are examples of the way in which biology may come in immediate contact with

[1] *Science and Culture*.

[2] To avoid a cumbrous form of expression, "Physiology" is used here to denote the study of all the normal processes of the animal, including those usually described as psychological.

national life: while in the domain of psychology "motion study," scientific management, mental tests for aviators, and vocational training, are among the applications on which the younger science is beginning to test its new-found freedom.

How is the Profession, as distinguished from the Science of Physiology, to find its place in our social system? Medicine is maintained by the urgent need felt by the sufferer for relief and help: the normal man equally may need advice and help, but he has not the same potent realisation of his need. It is necessary to call in motives more far-seeing than pain or fear to establish its existence. Such a motive may be found in the educated self-interest of a great industrial concern, which has appreciated the value of an impartial and critical investigation of the human factor in its success: or it may be found in the foresight of government or municipal bodies, or in the generosity of private benefactors, who have realised that the scientific study of normal man in relation to his inheritance and his environment is an essential stone in a rational structure for society. But in whatever way the profession can be created, it has no lack of opportunity for fruitful service.

The most urgent need for physiology is discovery—a more extensive knowledge of the physical, chemical, biological, and psychological factors governing the living creature. Such work can best be done at universities, with the intellectual stimulus of university life. Progress is within sight in all directions if only workers, equipment, funds, and leisure can be made available. But accompanying this discovery there is required, scarcely less insistently, an interpretation of its meaning in terms of human life: and this interpretation can be made only if there be a sufficient body of "professional" interpreters, men well trained, at least as well trained as the Medical Profession, in the elements of scientific thought, and given the duty of applying physiological methods and results to industrial, economic, and social problems. Society is built for man, not man for society: and an impartial scientific study of man in relation to the structure of society is a first condition if the structure is to survive the struggles and aspirations of its occupant.

BOOKS RECOMMENDED

General Practice and X-rays. By (MRS.) A. VANCE KNOX, M.B., and ROBERT KNOX, M.D., C.M. (A. & C. Black, 15*s*.)

A handbook for the General Practitioner and Student. Dr. Knox is well known as an authority on Radiography and Radio-therapeutics.

Principles of Human Geography. By ELLSWORTH HUNTINGTON and SUMNER W. CUSHING. (New York, John Wiley; London, Chapman & Hall, 21*s*.)

Sir James Young Simpson

JUNE 7, 1811—MAY 6, 1870

The Discoverer of the Anæsthetic Properties of Chloroform

By Edward Cahen, F.I.C., A.R.C.Sc.

ALTHOUGH Sir James Simpson's name will always be connected with the discovery of the anæsthetic properties of chloroform, he owed his fame really to his own personality, his great ability, and the reforms he introduced into the practice of medicine and surgery. These reforms were carried through by his indomitable will and fighting spirit. It is certain that, even if he had not discovered the power of chloroform to induce anæsthesia, he would nevertheless have reached the pinnacle of fame through his fight for anæsthetics, and because of his work as an obstetrician. It is of interest to note that such was his final victory for chloroform, that ether, the anæsthetic properties of which had been discovered earlier, was for many a long year banished from general use by the profession, and it is only in recent years that this substance has come again into general use.

Simpson was of humble Scottish birth; his father was the local baker in the small village of Bathgate, in Linlithgowshire, and the boy had to take his share in the business with his brothers. He was, however, early singled out as the son for whom special sacrifices were to be made in order that he might bring honour on his family. Apart from the help he thus received, which enabled him to receive an education which should fit him for his future, he owed his rise to fame entirely to his own ability and ambition. His one thought was to repay his people for what they had done for him. At the tender age of fourteen he left the parish school and went straight to the University at Edinburgh. His early upbringing had been in an exceedingly narrow atmosphere, but this did not prevent the lad from entering on his studies with that keen delight in the search after the truth, which was in such contrast to his early surroundings, and which always actuated him throughout his life. In 1830, at the age of but eighteen, he found himself a qualified practitioner, and two years later he graduated as Doctor at the University of Edinburgh, being one of the last candidates to undergo the ordeal of an examination conducted in Latin. His thesis so impressed his examiner, Thomson, the Professor of Pathology in the University, that he offered him the post as his assistant at £50 per annum. This the poor lad eagerly accepted as a means of relieving his family of the burden of keeping him, and he pursued his studies in pathology and midwifery.

Before settling down to a more remunerative occu-

pation, Simpson determined to enlarge his experience by a visit to the chief seats of medical learning in Europe, and for this purpose he paid visits to Paris, Brussels, and Liège, taking London and Oxford on the way. On his return, in November 1835, he was elected President of the Royal Medical Society in Edinburgh, and chose a subject for his address connected with obstetrics. He next accepted the post of house-surgeon in the Lying-in Hospital, and at the same time, owing to Professor Thomson's ill-health, gave the lectures on Pathology at the University. In 1837 he obtained the post of Extra-academic Lecturer on Midwifery, and two years later, on the retirement of the

SIR JAMES YOUNG SIMPSON.

Professor of Obstetrics in the University, this ambitious youth of twenty-eight applied for the vacant chair. After a great fight and the expenditure of much more money on canvassing than he could afford, he was elected by one vote by the Town Council in whose gift the chair lay. He even became engaged to Miss Grindley, of Liverpool, and married her during this anxious period of trial, for he thought that his youth and single state might prejudice his chances of election. On the evening of the day of his success he wrote to his father-in-law: "I was this day elected Professor. My opponent had sixteen and I had seventeen votes. All the political influence of both the leading Whigs and Tories here was employed against me; but never mind, I have got the chair in despite of them, Professors and all. Jessie's honeymoon and mine is to commence to-morrow."

From that time forth his reputation as a lecturer and an authority on the diseases of women increased, and his means became more affluent, so that he was able gratefully to pay off his debts to his father-in-law and his own family.

In his student days, the horrors of the operating-table were such as to defy description and exaggeration. On a sensitive youth such as Simpson, it was but natural that such a condition of things should have evolved feelings of disgust and a strong desire to alleviate the terrible sufferings, mental and physical, which the patients of those days had to bear when they were being operated on. With his customary industry and care, Simpson made a search through the records of antiquity to see what had been used in the past to induce insensibility. Indian hemp, he found, had been used under various names throughout the East for this purpose. Mandrake was another well-known drug (it was mentioned by Shakespeare) possessing narcotic properties. Methods of another kind had been tried, such as hypnotism; operations had actually been performed on hypnotised persons as recently as 1837. In 1800 Sir Humphrey Davy had discovered that laughing gas, an oxide of nitrogen, could produce a pleasant sensation of intoxication, and suggested its suitability for use in minor operations. Some thirty years later Faraday discovered that if ether were inhaled it had very much the same effect, but it was left to the Americans, Wells and Morton, to induce complete anæsthesia, and adapt the earlier experiments to practical ends. Wells was the first to have a tooth extracted under the influence of laughing gas (1844), and two years later Morton, who had not been so successful with laughing gas, found that ether would much more easily produce the same effect. He actually anæsthetised himself by inhaling this substance on his handkerchief.

Early in 1847, the year in which he was appointed Physician Accoucheur to Queen Victoria in Scotland, Simpson, still a young man, began to use ether systematically in his large obstetric practice, thus gaining for the Edinburgh Medical School the honour of being the first place where use was made of the new means of alleviating suffering. He was not, however, entirely satisfied that the best substance had been discovered for this purpose, and he set about searching for the ideal drug that would produce the effects that had already been produced by ether and laughing gas. This work was done in the evenings at his house in Queen Street, a house which had already attained fame as the resort of anyone of importance who happened to be

visiting Edinburgh. Here, assisted by his devoted disciples, he began to try all sorts of liquids on himself and his assistants in the hope of discovering the ideal. A certain Mr. Waldie, a Liverpool chemist, who originally came from Simpson's own county, suggested chloroform as a likely liquid for the purpose. Simpson had already had some chloroform, but had set it aside as being heavy and unpromising for the purpose. The bottle containing the heavy oily liquid was accordingly fished out again from numbers of others and its contents sampled. It was on the 4th of November 1847 that the discovery was made that this unpromising, sweet-smelling liquid would do all that was required of it and do it extremely well. Chloroform had been discovered by Liebig in 1831, and independently by Soubeiran in the same year.

Now began the usual battle that we have already witnessed in the case of Pasteur [1] and Lister,[2] a battle against ignorance, prejudice, and professional jealousy. Simpson, unlike Pasteur, who was worried by his opponents, entered the contest with the keenest delight, and wrote long dissertations, often in a humorous vein, to confound his enemies, making them appear ridiculous in the eyes of the world.

His greatest delight was to fight them with their own weapons ; thus he met those who objected on religious grounds by quoting Genesis ii. 21, " And the Lord God caused a deep sleep to fall upon Adam ; and he slept, and He took one of his ribs and closed up the flesh instead thereof." By April 1853 the victory had been completely won, for then the Queen was anæsthetised with chloroform. The methods of administration of chloroform at Edinburgh were so excellent that they have remained unchanged to this day, and practically no other anæsthetic is used in that school. The discovery of anæsthesia, and more particularly the discovery of chloroform, caused a complete revolution in the field of surgery and obstetric practice, coming as it did almost simultaneously with Lister's great discovery of antisepsis. The two together rendered surgery not only comparatively safe, but also painless. The whole atmosphere of the operating theatre was completely changed from a scene of horror resembling a shambles, to the calm and peace that surrounds the surgeons of to-day in the orderly theatres of our great hospitals. Simpson narrowly escaped fame from an entirely different discovery of a means of stopping the bleeding of the severed arteries in major operations. Hitherto these had been tied with silk of doubtful cleanliness, which as often as not set up local blood-poisoning. Simpson devised a method known as " acupressure," which was, however, superseded by Lister's antiseptic soluble ligatures. Simpson's work on Hospitalism, long before Lister's discovery had brought about the revolution it did, had done much to improve the conditions in these institutions. He suggested rebuilding, cleansing, and segregation, and his plans would have done much to arrest the appalling mortality prevalent in the hospitals of those days, had Lister's antiseptic surgery not come in just as his efforts were about to bear fruit. Though Simpson had been tempted to desert Edinburgh for St. Bartholomew's Hospital in London, he remained faithful to the city of his choice until death. A grave in Westminster Abbey was offered, though the offer was declined by his family as he had himself chosen his last resting-place on the hills surrounding his beloved city.

[1] DISCOVERY, November 1920. [2] DISCOVERY, January 1921.

NOTE.—*Sir James Young Simpson and Chloroform*, by H. Laing Gordon, in the *Masters of Medicine* (Fisher Unwin, 1897), is recommended for a short, concise account of this great physician's life.

The Psychology of Religious Experience

By Robert H. Thouless, M.A.

Corpus Christi College, Cambridge

WE do not give a sufficient account of religion by describing it simply as a particular mode of behaviour, or as a system of beliefs, or as a particular system of emotions. It is all of these things. It includes a peculiar kind of behaviour, of which worship is the principal part. It has a system of beliefs which are the necessary accompaniment of this behaviour ; worship is impossible without a belief in a Being or beings to whom that worship is offered. It is, however, with the emotions accompanying religious behaviour that this article is concerned. These are usually given the name of " religious experience."

It is probable that all persons feel religious experience at some time in their lives, though it is only in the religious mystics that it plays a dominant part in the shaping of their conduct. The sense of peace after prayer or sacrament, or of exalted emotion after a stirring sermon, are examples of religious experience. Other examples may be found in the feeling of the presence of God as described by Brother Laurence in his book on *The Practice of the Presence of God*, or even in the vague feeling of an intimate presence in nature—such as that given by Thoreau in the chapter on Solitude of his *Walden*.

Certain religious practices have as their aim the intensification of the emotional experiences of religion. This is avowedly the object of the " contemplations " and " colloquys " of the Spiritual Exercises of

St. Ignatius Loyola, and of the control of breathing and posture which is more developed in Eastern religions. A similar intensification or religious experience is also the result of practices in which this is not the conscious intention. Such are: fasting, the use of oratory in pulpits, of solemn music and ritual, of lighted candles, and of a monotonous voice in the reading of the religious service.

It must be the task of the student of the psychology of religion to explain the facts of religious experience in terms of the same psychological theories as are used to explain the facts of our ordinary mental life. A religious psychology which explains every new action of the mind by the creation of a new faculty, which, for example, explains our sense of the presence of God by speaking of a "transcendental consciousness," is really abandoning the task of giving a scientific account of religious psychology altogether. We may, of course, find that it is impossible to give an account of the mental phenomena of the religious life in terms of our ordinary psychology, but the method just described would still be open to criticism. It professes to have given an explanation when it has, in fact, merely repeated the facts which it was trying to explain.

We must notice at the same time that our hope of finding it explicable in terms of the ordinary operations of our minds is not a hope that religious experience may prove illusory. In the physical world we see the finger of God in events which take place in accordance with law, and there seems to be no reason for taking a different attitude towards mental events. Conversion may take place in accordance with laws as fixed and definite as those obeyed by the lightning flash (though it is unlikely that we shall ever be able to demonstrate that it does), but this would be no reason for denying the truth of the religious explanation of it.

Discovery in the psychology of religion is therefore very largely the application to religion of discoveries made in secular psychology. In such advances the history of psychology during the last thirty years has been rich. The attention of psychologists has turned away from the problems of the old analytic introspective psychology, which was principally occupied with questions connected with cognition and perception. It is now much more concerned with questions of greater human interest, with the driving forces behind human conduct—instincts and emotions. The older psychology was of great importance for the philosophy of religion, since it discussed the problems of knowledge; the newer psychology is of equal interest to the psychology of religion, since it discusses the mental roots of man's behaviour, including his religious behaviour.

The discoveries in psychology whose connection with religious experience I wish particularly to point out in this article are those made by Freud and his followers. It may be objected that it seems perilous to found any conclusions on a system of theories which is itself being hotly contested by psychologists. At the same time, we must recognise that, however much psychologists may differ from Freud and his school in matters of detail, there are broad general principles revealed by his work which can never be overthrown because they are founded on the firm basis of observed fact. The discussion in this article will be limited to such firmly grounded principles.

The first of these is the fact that a large number of our thoughts and actions have their causes in mental processes which are unconscious. By an unconscious mental process is meant one which we are not aware of, and of which we cannot make ourselves aware by any redirection of our attention. Thus, if a clock is ticking in a room in which we are working, and though we are not aware of its sound, we can immediately become aware of it by listening to it, the hearing of the noise would not be an unconscious mental process in the sense in which the word is used by Freud. Examples of true unconscious mental processes may be found in an article on "Mistakes" in the DISCOVERY of last April. The wishes which express themselves in dreams and in certain mistakes in speech or writing are unconscious in this sense. Experiences painful in themselves—as, for example, some of the horrible experiences of the war—or wishes which become painful because of the impossibility of their fulfilment, are banished from the mind by an unconscious process called "repression." They are no longer present to consciousness, but can still exert an influence on the behaviour and emotional dispositions of the person possessing them. In certain cases they lead to forms of insanity.

We will take a typical case of religious conversion, and see how far the process of repression can help us to understand the mental processes which precede it. The story which follows is of the conversion of M. Ratisbonne which is given in *The Varieties of Religious Experience*, by W. James.

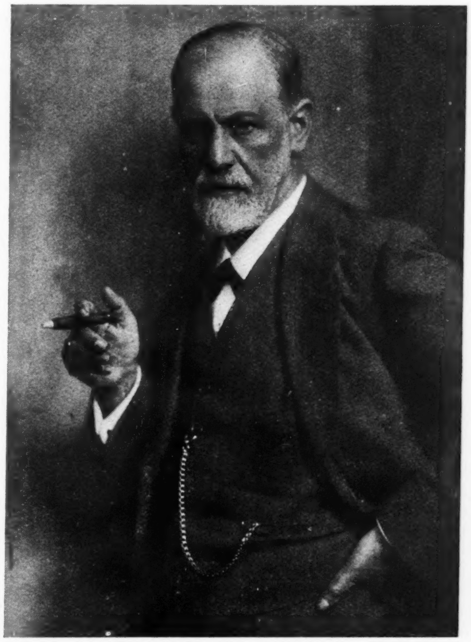
M. Ratisbonne was a Jew who became converted to Catholicism. He was irreligious, and had an antipathy to priests. In his twenty-ninth year a French gentleman tried to make a proselyte of him, but M. Ratisbonne did not take his efforts seriously, his own part in the conversations being of a light and chaffing order. But the words of a prayer to the Virgin he promised to read haunted his mind for several days, and the night before the crisis he had a sort of nightmare in which he saw a black cross with no Christ on it. Until noon the next day, however, he was free in mind, and spent the time in trivial conversations. By chance on that day he met his friend, who asked him to wait for a few

minutes while he went inside a church. M. Ratisbonne entered the church himself to look at it while he was waiting. Suddenly he passed through an experience he was unable afterwards to describe, in which he saw a vision of the Virgin. His friend found him prostrate on the ground, weeping. He felt the most ardent joy in the bottom of his soul. He asked for a priest. He felt that a bandage had fallen from his eyes, and he had acquired a knowledge and a faith of the truth, of which he could give no account.

This account shows the characteristic feature of suddenness which makes conversion such a striking mental event. Modern psychology explains such suddenness as due to the fact that the mental processes which resulted in the conversion were unconscious. We must suppose that, if we could have examined the unconscious mind of the convert before the event, we would have found that he had already begun to believe in Christianity, but that the change was repressed because of its conflict with the feelings and sympathies of his earlier life. The moment of the conversion was the moment when this repressed conviction became strong enough to overthrow the resistance to it, so that for the first time it became present to consciousness. Such unconscious processes, though they are banished from the conscious mind, can express themselves in dreams. The violently emotional dream which M. Ratisbonne had dreamed during the previous night shows that his unconscious mind was seriously occupied with the question of Christianity, although his conscious mind was not. His antipathy to priests may also be an indication of unconscious leanings towards Christianity. A violent and unreasonable prejudice against something is often a method by which the mind compensates for an unconscious attraction towards it. It is typical of the results of conversion that M. Ratisbonne felt that he had suddenly acquired a new knowledge, but was unable to give any account of the mental processes which led up to it. The psychologist explains this as the result of the fact that the mental processes leading up to it were unconscious, not that they were absent altogether.

A second fact which seems unmistakably to emerge from recent work in psychology is the very large part played in human activity by the love-instinct. That this is the case in religion is no new discovery of modern psychology. The fact that human and religious love are intimately related to one another has been guessed by many persons who have used their knowledge of this relationship either to depreciate religious enthusiasm or to exalt human love. The best example of the second of these two attitudes is probably Coventry Patmore. This is the theme of many of his poems. In one of his prose works he says: "There comes a time in the life of everyone who follows the Truth with full sincerity when God reveals to the *sensitive* Soul the fact that He and He alone can satisfy those longings, the satisfaction of which she has hitherto been tempted to seek elsewhere." In another passage he speaks of "that human love which is the precursor and explanation of and initiation into the divine." [1]

An American psychologist says: "Religion is at its best when its earthly image is most spotless and untarnished, and love is at its best where religion is purest and most undefiled. Just as this relationship



DR. S. FREUD, OF VIENNA.

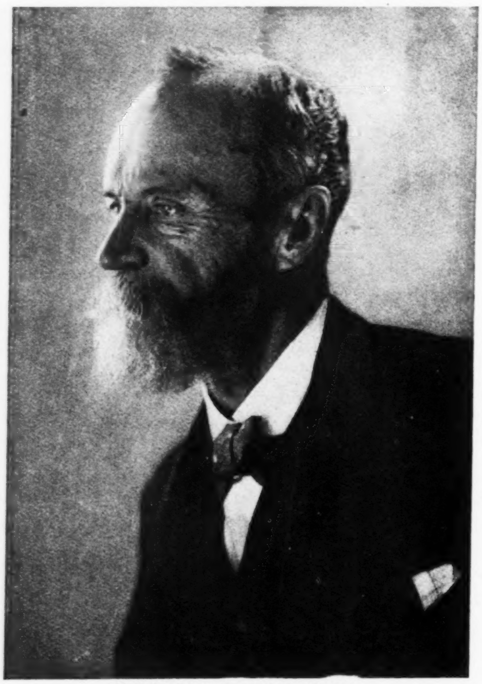
seems to degrade religion only to those whose ideals or cults of love are low or undeveloped, so those who dispraise religion have not realised how indispensable it is to perfect love. How central this thought was to Jesus many parables and sayings attest. True piety is earthly love transcendentalized, and the saint is the lover purified, refined, and perfected." [2]

The first indication of the intimate psychical connection between human love and the mystics' love of God is the frequency in their writings of language drawn from human love. Many of the mystics have found a congenial mode of self-expression in the Song of Solomon, which is purely a love song. Blosius prays in the following words: "O my beloved, my

[1] *The Rod, the Root, and the Flower*, Coventry Patmore.

[2] *The Psychology of Adolescence*, by Prof. G. Stanley Hall, vol. ii, p. 294.

beloved, my beloved! O dearest of all friends, O my one love! O spouse of my soul, flower of love! Spouse of my soul, sweeter than honey in the honeycomb! Ah, sweetness, sweetness, sweetness of my heart, life of my soul! O calm light of my inmost soul! O Lord, my God! O most holy Trinity, one God, brighter than light, giving all delight, feed me, feed me; feed my soul with Thy inflowing grace."[1] Similarly Suso prayed: "Ah, my beloved! Thou art indeed an Easter Day of joy to me. Thou art the bliss of summer to my heart, and the hour of my de-



PROFESSOR WILLIAM JAMES.
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light. Thou art the loved One, whom alone my young heart loves and thinks upon, and for whom it has scorned all earthly love. Let this avail me now, my heart's beloved, and let me obtain a garland from Thee to-day. Ah, gentle heart! do this for Thy divine virtue's sake, and for Thy innate goodness, and let me not depart from Thee with empty hands this New Year's Day."[2]

Some of the visions of the saints have forms which are the same as those of the day-dreams of normal persons. Thus the Lady Julian records a vision

[1] Cited in *The Graces of Interior Prayer*, by A. Poulain, S.J., chap. xxv.

[2] *The Life of Blessed Henry Suso*, translated by T. F. Knox, chap. x.

which follows the outlines of the birth phantasy, but which has for her a religious significance: "And in this time I saw a body lying on the earth, which body showed heavy and horrible, without shape and form, as it were a swollen quag of stinking mire. And suddenly out of this body sprang a full fair creature, a little Child, fully shapen and formed, nimble and lively, whiter than lily; which swiftly glided up into heaven. And the swollenness of the body betokeneth great wretchedness of our deadly flesh, and the littleness of the Child betokeneth the cleanness of purity in the soul. And methought: *With this body abideth no fairness of this Child, and on this Child dwelleth no foulness of this body.*"[1]

Lastly, we may notice the very high valuation placed by religion on chastity. In mysticism, where the whole of the psychic energy is directed towards God, none can be spared for a human object of love. By a psychological necessity, absolute chastity is required for the mystic, and in religions in which the contemplative life is considered to be the highest, chastity is recognised as a desirable thing although it is not obligatory. It is an important, because it is a particularly difficult, part of the cutting one's self free from creatures which the mystics speak of as a necessary preliminary to entire devotion to God. An extreme example of this high valuation of chastity is found in the life of St. Louis of Gonzaga, who at the age of twelve, if by chance his mother sent one of her maids of honour to him with a message, "never allowed her to come in, but listened to her through the barely opened door, and dismissed her immediately. He did not like to be alone with his own mother, whether at table or in conversation . . . and he made a sort of treaty with his father, engaging promptly and readily to accede to all his wishes, if he might only be excused from all visits to ladies."[2]

A second point of importance in this connection is the common occurrence of conversion of a particularly emotional kind at adolescence. A very large proportion of conversions take place at adolescence, and these adolescent conversions have certain well-marked peculiar features of their own. They seem to be most satisfactorily explained by supposing that the growing energy of sex, which has been repressed by its failure to find satisfaction in a human love object, becomes directed towards God, but this redirection is less deep seated than in the case of the mystic. The emotional intensity of the adolescent conversion passes away, though it may leave behind it a religious sentiment which is permanent.

These facts do not compel us to the acceptance of

[1] *Revelations of Divine Love*, by Julian of Norwich, chap. lxiv.

[2] *Life of St. Louis of Gonzaga*, by Meschler; cited *Varieties of Religious Experience*, by W. James, p. 351.

a theory put forward by certain American psychologists under the name of "erotogenesis," which asserts that all religion is merely misinterpretation of sex-feeling. Simply on the psychological level, there are many other constituents of religion : group sentiment, the moral conflict, etc., all of which contribute to religious experience. Moreover, there is nothing in these facts themselves to justify us in concluding that the objects of religion are unreal. The fact that we love God with, in some sense, the same love as that with which we love man, is no evidence that our belief in God is an illusion. We have seen that this is substantially the conviction of such a firm believer in God as Coventry Patmore.

It is, indeed, possible that investigations into the nature of religious experience along these lines may provide reasons for believing in the reality of its object. Freud considers that one of the causes of a large number of mental diseases is the failure of the psychic energy [1] to find satisfaction in an object of love. To a certain extent, it is possible to escape such mental troubles by the redirection of this energy into other valuable channels. This redirection is called "sublimation." Thus, the mind which devotes its energy to social work or to artistic production is less likely to become diseased through a failure to find happiness in love. If the mind retires too far from the world of realities and finds its sole satisfaction in a phantasy world of its own construction, it develops a form of insanity. In any very complete redirection of the psychic energy through religious channels, there is also a retirement of the mind from the outside world, but with a different result. The person concerned does not become mad. He has found an outlet for his psychic energy which provides him with a satisfactory basis for healthy mental life. There is a possibility that it is legitimate to argue that the satisfactoriness of the religious redirection of the psychic energy is the result of the fact that the object of religious love is real, and not, as many psychologists would have us suppose, a phantasy creation of our own minds.

We must, therefore, recognise the importance of this transformation of human love as a factor in religious experience. The emotions of the mystic and of the adolescent convert are emotions familiar to us in the sentiment of earthly love. The mystic's alternation of periods of intense emotional fervour and of reaction or "dryness," his temptation to find the meaning of his experiences in the emotional pleasures themselves rather than in the guided activity which should be their product, may be paralleled on the plane of human love. It is, however, important that the significance of this relationship should not be exaggerated. Probably we appreciate this significance best when we are led by it to see something sacred in human love, rather than when we find in it a cause of reproach to religious love.

[1] The word used by Freud is "libido." I have preferred to take the term "psychic energy" from Jung, since it is less likely to be given an exclusively sexual meaning. It is used as a term to cover the energy behind all kinds of desire.

BOOKS FOR FURTHER READING

ON THE PSYCHOLOGY OF RELIGION

The Varieties of Religious Experience, by William James. (Longmans, Green & Co., 12*s*. net.)

The Mystical Element of Religion, by Baron F. von Huegel, 2 vols. (Dent, 21*s*.)

The Religious Consciousness, by Prof. J. Bissett Pratt. (The Macmillan Company, New York, 1920, 22*s*.)

ON THE FREUDIAN PSYCHOLOGY

The Psychology of Insanity, by Dr. Bernard Hart. (Cambridge University Press, 1918, 2*s*. 6*d*.)

A General Introduction to Psycho-analysis, by Prof. S. Freud. (Boni & Liveright, New York.)

Metric Systems

By A. E. Crawley, M.A.

Author of "The Book of the Ball" and of "Lawn Tennis," etc.

AT the recent meeting of the British Association the suggestion was made that, in view of the decreased purchasing power of the penny, the pound sterling should be divided into two hundred instead of two hundred and forty pence. This would decimalise our coinage—sixpence would become fivepence, a shilling tenpence, half a crown twenty-five, and so on.

Periodical attempts are made to introduce a Bill for changing our system into a decimal system. But why not decimalise our weights and measures also ?

A uniform world-system of numeration would obviously be a boon to international trade, and other international relations. The Olympic games, recently held, showed once more the inconvenience of conflicting national systems of measuring. The 100 metres footrace is 109·36 yards ; the 400 metres race is 37·44 yards longer than our classic quarter mile. The equivalent of our mile is the 1,600 metres race of 1,640·4 yards ; and so on.

In the relative measurement of dress fabrics, as between, e.g., Switzerland and Great Britain in the silk trade, the reduction of the two systems, so Swiss merchants inform me, is a permanent nuisance, especially as the English yard and the Continental metre are *incommensurable*.

The essential points in a convenient system are ease

of multiplication and division in small and large figures, and of automatic addition and subtraction in both. Here the decimal system, unwarrantably styled by many " the metric system " (as if " metric " were the adjective of " metre " only), seems to score. But the " point " or comma which marks off tens from hundreds and hundreds from thousands is easily misplaced, and sojourners on the Continent have often suffered in consequence. Another objection to Napoleon's system of numeration is that the franc cannot be so conveniently quartered as the old English shilling. Two and a half centimes (the quarter of a tenth of a franc) brings in the inconvenience of half-pennies, while threepence does not. Any unit of measure or weight or currency should be easily halved and quartered, the most primitive and permanent form of division and of fraction.

The British methods (they can hardly be styled a system) of numeration in coinage, measures, and weights are a remarkable conglomeration of survivals from ancient systems. It is worth while enumerating the chief systems that have been used by man ; a consideration of them will go to show that the decimal system (the so-called " metric " system *par excellence*, the World Trade Club's " meter-liter-gram ") is far from being a perfect system, and that there have existed better, at least for every-day use.

The way to consider these systems and to test them is to find their distinctive *unit* and examine its *divisional capacity*. Incidentally the multiplicational capacity will be remarked. The systems are in two groups, decimal and duodecimal (in twelves).

Most primitive peoples (the man in the street calls them savages, and Prof. L. T. Hobhouse the " simpler societies ") count by the fingers and toes, representing a convenient *abacus*. The method is not 1, 2, 3, 4, 5, exactly, but 1, 2, 3, 4, hand, and so on. It is curious that even now, in some English elementary schools, the counting is done similarly. A second " hand " makes up " half a man " ; the two feet complete " a man." This is a quinary (in fives) system, well illustrated by the Roman numeral figures, I, II, III, IIII (IV = V minus I), V, the last being a pictograph of the held-up hand ; VI, VII, VIII explain themselves, IX is X minus I, and X is a pictograph of two hands, XX of four.

As E. B. Tylor said, the decimal system, including the quinary and vicesimal (in twenties), was deduced from human anatomy. One great advantage of this group of systems is the principle of percentage. In the history of sociological arithmetic few things have been so useful as " per cent." On the other hand, decimal fractions do not come instinctively to the average mind, but, as on the Continent, the slightest instruction makes the method automatic.

The other great group of systems has twelve or sixty as its main units. The sixty system is traced to the ancient Babylonian culture, as is shown by the tablets of Senkerah, sixty being a *soss*, and sixty by sixty a *sar*. Sexagenary applies to multiplication by sixty, sexagesimal to division of or by sixty. Ptolemy, in the second century, applied this system to the calculation of degrees. He made the degree sixty, the minute a sixtieth of the degree, and the second a sixtieth of the minute. The Roman and mediæval mathematicians adopted the system, and exploited it further, in the calculation of time. They divided the day into twice twelve hours, the hour into sixty minutes, the minute into sixty seconds. In mediæval Latin the divisions of the sixty unit were *partes minutæ primæ*, and of these the sixtieth parts were *partes minutæ secundæ*. Hence our terms minutes and seconds, both for time and space.

A curious remainder of this sixty-system, as the present writer has shown, is in the scoring of tennis by fifteens. This has been a puzzle since 1555, when the Italian Scaino attempted to solve it. The game was a unit of sixty divided into four strokes—fifteen, thirty, forty-five, and sixty. To this day, in France, the original forty-five is used in *la paume*, our tennis, instead of our abbreviation forty.

The reason behind the selection of 60 as a unit is clearly the fact that it is *divisible by more numbers than is any other*. Sixty is divisible by twelve numbers, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, and is halved and quartered conveniently. Ten, the unit of the decimal system, is divisible by four numbers, 1, 2, 5, 10, and cannot be quartered without a fraction. Twenty, the unit of the vicesimal system, is divisible by six numbers ; so is twelve. A hundred is divisible by nine numbers. The duodecimal (twelve) being multipliable into sixty, as in clock reckoning, and thus including twelve sets of fives, is, in this larger form (the sexagesimal), superior to the decimal, whose half-unit is five, and which cannot be quartered without a fraction. The decimal system retaliates by dividing its units into tens, hundreds, thousands, etc., and multiplying them into trillions. But Tylor concluded that " duodecimal arithmetic is a protest against the less convenient decimal arithmetic in ordinary use."

The British numerational methods comprise halving and quartering, and the various forms of the decimal and duodecimal systems, viz. quinary, decimal, vicesimal, centesimal ; and senary (six), duodecimal, and sexagesimal.

To take the salient instances, halving and quartering, of course, are universal, with a curious preponderance in dry measure and liquid measure. Thus, a bushel divides into four pecks, a peck into two gallons, a gallon into four quarts (i.e. quarters), a quart into two

pints; a pint, a peck, and a pound are each divided into "quarters." Again, a pound is divided into sixteen parts (ounces) in avoirdupois. The fact of having troy and avoirdupois is confusing; merchants recently have been discarding the former. Four "quarters" go to a hundredweight, and eight stones to a hundredweight. In measure, one mile divides into eight furlongs, two half and four quarter miles; and four fingers make one palm, sixteen fingers one foot.

The decimal and duodecimal systems fit in with this halving and quartering very neatly. One pound [1] is twenty shillings; "half a sovereign" is ten. A shilling is twelve pence; half a crown is thirty; a crown (now obsolete) is sixty. It is like tennis scoring, although the coinage lacks pieces of fifteen and of forty-five pence. In France, between 1310 and 1410, there was a predominance of coins value fifteen and sixty. When you have quarters, halves and three-quarters need not be separately struck. Further examples of the duodecimal and sexagenary systems—a "pound Scots" is one shilling and eightpence, one-twelfth of a pound; one dram is sixty minims; one "pennyweight" is twenty-four grains; the ell is two-thirds of sixty inches; twelve ounces (troy) are one pound.

One sees something in the Roman single principle that an *uncia* was the twelfth of anything, and an *as* twelve times anything, coin, weight, or measure.

But the writer, though he has an antiquarian predilection for the duodecimal and sexagesimal systems, is aware that their usefulness is in division only, and of small amounts; he would therefore welcome a wholesale introduction of the decimal system.

Arrested Inventions

By Herbert W. Horwill, M.A.

WHAT is, perhaps, the most sensational of recent triumphs of invention—the conquest of the air—was long overdue. Ever since the day when Icarus presumed too greatly upon the skill of his father, Dædalus, the world has been prepared to hear any morning that man had at last acquired the powers of the bird. Indeed, one might almost say that there has been more disappointment at earlier failures than astonishment at the successes recently achieved. It is not in this section only of the wide field of invention that each stage in the process has been curiously hampered by a difficulty about the next step. "A little more and how much it is." Again and again a promising advance has been brought to a halt by an obstacle that, in the retrospect, seems almost trivial. It may be that generations or even centuries pass before there flashes into someone's mind the illuminating idea that enables this hindrance to be surmounted.

This arrest of invention has been abundantly illustrated in the history of transit by land as well as by air. In view of the part that steam has played in modern methods of transport, as well as in industry generally, one is amazed to learn that its use was anticipated early in the Christian Era. In a treatise written about A.D. 130, Hero of Alexandria describes a hollow spherical vessel turning on an axis, which vessel was supplied with steam and driven by the reaction from escaping jets. Yet the belief that there could be any mechanical value in the expansive power of steam seems to have slumbered through the ages, not to awaken until the seventeenth century, when there began the series of experiments culminating in Watt's famous invention of 1769. A crude anticipation of the modern railway existed near Newcastle-on-Tyne as long ago as 1676, when coals were conveyed from the mines to the river along parallel rails of timber. "Bulky carts were made," so we are told, "with four rollers fitting those rails, whereby the carriage was made so easy that one horse could draw four or five chaldrons of coal." The story of the various contrivances that prepared the way for George Stephenson's railway engine is familiar to all students of our industrial history. The motor-car of our own time certainly appears to be one of those inventions that should have come earlier, when one remembers the road locomotives of Oliver Evans in America and of Trevithick in Wales more than a century ago. It is now generally known that one of the latest adjuncts of the public motor, namely the taximeter, was used by the Chinese. Vitruvius, too, who flourished before the Christian Era, describes a practical taximeter which the Romans attached to their chariots. Perhaps even the development of steam navigation might have been expected sooner, inasmuch as the ship's paddle is only an application of the familiar water-wheel, and the screw propeller an extension of the vanes of the windmill.

Still more remarkable are the instances of long delay in the discovery of improvements in the arts that have to do with reading and writing. How strange it seems to-day that so many centuries of literary activity should have passed before anything corresponding to our "running hand" was thought of! One is surprised that the painfully slow process of writing in capital letters, or in that kind of half-capital which is known

[1] The origin and the reason of the survival of the guinea do not come within the scope of this article. It might be pointed out, however, that one of the reasons why it is cherished by lodging-house and hotel keepers is that it is divisible by *seven*, the number of days in the week.

to palæographers as "uncial," should have survived so long after the primitive carving of literature upon stone had been superseded by the introduction of papyrus and parchment. A glance at any collection of ancient manuscripts of the fourth and fifth centuries A.D. makes one wonder also that no Greek or Roman writer of that period should have seen what an advantage it would be to separate successive words by blank spaces, as had been regularly done on inscriptions both at Athens and Rome in earlier times.

Though the European world had to wait until the fifteenth century for the invention of printing as we know it, many of the most important elements of this art were familiar long before. The existence of coins in remote antiquity shows that the use of moulds was early understood. In the time of Virgil, brands with letters were used for marking the owner's name on cattle, and articles of merchandise were stamped by a similar process. Yet, while coming so near the epoch-making invention of movable type and the press, the Romans had to depend upon the labour of scribes to reproduce their documents and books—and newspapers—for they were "progressive" enough to publish a daily gazette. In discussing this topic it is inevitable to refer to the Chinese, who printed from wooden blocks in the tenth century of our era. The development of the art is often supposed to have been arrested in their case by a failure to take the next step of separating characters in the form of movable types, but it has lately become known that they were actually doing this four hundred years before Gutenberg set up his press at Mainz. There seems to be no evidence, however, that the Chinese anticipated Schöffer's plan of casting these types from matrices, instead of cutting them individually. It is worth noticing, by the way, how one of the most important later developments of printing has been, in a sense, a reversion to the earliest methods of all, for, when you print from a stereotype plate whose component letters cannot be "distributed" and used another time, you are once more printing from a solid block. A detailed examination of the successive improvements in the mechanism of the press itself and in the various devices for "composing" by machinery would illustrate in like manner how success has been reached by a series of stages, with long halts between. The typewriter, again, is an invention that has passed through a long apprenticeship, for as long ago as 1714 a patent was taken out in this country by Henry Mill for a "machine for impressing letters singly and progressively, as in writing, whereby all writings may be engrossed in paper, so exact as not to be distinguished from print." The next step was not taken until more than a hundred years later, when the "typographer" was patented by an American, W. A. Burt. Before departing from the literary side of our subject, it may be as well to recall that the card catalogue—that convenience of the modern library—first suggested itself to the ingenious mind of a French abbé of the Revolution period. He wrote the titles of his books on playing-cards, and arranged them endwise in alphabetical order on a tray. But the first general application of the idea was made by an American librarian in the middle of the last century.

Photography is an art that several times seemed on the verge of being discovered. A camera obscura was exhibited by Battista Porta in the sixteenth century, and there are records of such cameras even before his time. Thomas Wedgwood succeeded at the beginning of the nineteenth century in making profiles by the action of light upon silver, but it was many decades later that the attempt to take portraits by similar means became anything more than the curious hobby of an experimenting chemist. There is a number of other inventions—including the mariner's compass, gunpowder, and the sewing-machine—whose history it would be interesting to trace. But of all the examples of arrested development in the application of mechanical methods there is none more peculiar, in some respects, than one revealed by an incident which occurred in a British colony. About 1842 the area under wheat cultivation in South Australia had increased far beyond the capacity of the working population to reap the harvest. So urgent was the need of help that the Imperial troops then doing duty in the colony were ordered into the fields to assist. Thereupon a local miller named Ridley devised a labour-saving machine called the "stripper," which, while it was being drawn through the corn by a pair of horses, pulled the heads off the straw and threshed them. This immediately reduced the cost of harvesting from 2*s.* to 3½*d.* a bushel, and made the growth and export of grain a flourishing industry. Now, the odd thing is that Mr. Ridley derived his "happy thought" from an article in an old encyclopædia about a reaping-machine worked by oxen on the extensive plains of Ancient Gaul, and described by the Latin writers on agriculture. To use a metaphor appropriate to the subject, could one imagine a more remarkable instance of an idea becoming fruitful after lying fallow for many centuries?

It is tempting to speculate on the causes which have at one time and another prevented the rapid development of the germs of invention. Sometimes the peculiarities of national temperament seem in large measure accountable. It cannot be by a mere accident that China provides so many examples of arrested growth, while her neighbour, Japan, with less power of origination, has borrowed so many Chinese contrivances, in the fine arts as well as in mechanics, and has improved on

them. Much depends also upon social environment. Among the Romans the existence of large resources of slave labour discouraged the exercise of ingenuity. What stimulus was there toward inventing means of rapid reproduction of documents when slave copyists were at hand? Account must also be taken of the fact, noted by the late Professor Bain in his *Mental and Moral Science*, that as a rule it is only in modern times that the perception of similarities has been a force making for invention, as in the case of the "governor balls" of Watt. And, of course, we must never forget what mechanical progress owes to the enunciation of Bacon's great maxim that we cannot conquer Nature save by obeying her laws.

Reviews of Books

A Textbook of Plant Biology. By W. NEILSON JONES AND M. C. RAYNER. (Methuen & Co., 7s.)

An Introduction to the Structure and Reproduction of Plants. By F. E. FRITCH AND E. J. SALISBURY. (G. Bell & Sons, 15s.)

There has recently been a fairly general tendency on the part of botanists to modify their methods of teaching; for many years the practice was to illustrate the characters of the various groups of plants by the description and examination of seleeted types, to pay comparatively little attention to the chemistry and physics of the living organism, and to emphasise form and structure rather than the methods by which plants live and react to their environment. The enormous advance in recent years in our knowledge of Biochemistry, that is the chemistry of living things, has demonstrated the importance of introducing the student at an early stage to the conception of plants as working machines requiring energy, and depending for their efficiency upon chemical reactions in the living cells. The more old-fashioned methods of presenting the subject did not sufficiently recognise the unity of life. It is still difficult for many people to grasp the fact that plants are just as much alive as animals, and that the two kingdoms represent divergent lines of evolution from common ancestors which were neither plants nor animals as these are generally understood.

The book on Plant Biology by Professor Jones and Dr. Rayner is divided into three parts: The plant as a machine; the plant in relation to the outside world; reproduction. Throughout the volume there are directions for simple and well-chosen experiments. A student who has mastered the course of study proposed cannot fail to realise the nature of the problems with which a plant is confronted and the means by which the problems are solved. As the authors point out, their book does not profess to be a general treatise; it introduces the reader to the fundamental principles of Biology, and encourages him to see things for himself and to take as little as possible on trust.

The volume by Professor Fritch and Dr. Salisbury is a sequel to their *Introduction to the Study of Plants*, and while complete in itself, within the limits suggested by the title, it is primarily a textbook for students who wish to carry the study of plants beyond the stage at which a knowledge of minute structure and details of life-histories was not demanded. The authors state that they have "abandoned the study of isolated types in favour of a more general account, indicating the range of form and reproductive methods within each group." They have also endeavoured "to combat the frequent ignorance of botanical students with respect to the ecomonic aspects of their subject." The book is clearly written and on the whole well illustrated; the comparative method of treatment is an attractive feature to which greater prominence is given than in many textbooks. The physiological side is not neglected, and as far as possible structure and function are considered together.

These two volumes may be recommended with confidence as trustworthy guides to the modern method of studying botany, and the latter volume forms a suitable companion to that on Plant Biology. In both the subject is made attractive by a breadth of view and by emphasis on physiology. Elementary students with some knowledge of chemistry and physics can easily follow both pairs of authors; advanced students will learn a good deal, and the teacher will find many useful hints for practical exercises and methods of presentation.

A. C. SEWARD.

Devonian Floras: a Study of the Origin of Cormophyta. By E. A. NEWELL ARBER, with a Preface by DR. D. H. SCOTT. (Cambridge University Press, 17s.)

This book was prepared for the press by Mrs. Arber from a first draft written by Dr. Arber shortly before his death in 1918. Dr. Scott, in the Preface, gives a brief summary of the several chapters, and writes sympathetically of the "bold and vigorous effort" made by the author to grapple with the problems of evolution presented by the oldest known land-plants. Dr. Newell Arber, of whom an excellent photograph is reproduced as a frontispiece, was one of the most devoted workers in the attractive field of palæobotany; his researches added very considerably to our knowledge of fossil plants of different ages, and his more general papers dealing with questions of theoretical interest were both able and stimulating. In this his last work he gives an admirable summary of the salient features of Devonian plants described from many parts of the world, and discusses, with much independence of thought and originality, the bearing of the botanical data upon the evolution of the earliest land-plants. The theory advanced in the latter part of the book, which had not been revised by the author, of the origin of the Cormophyta—that is, plants exhibiting a differentiation into definite organs performing different functions—raises many controversial questions;

and while his conclusions will doubtless meet with some adverse criticism, they represent a solid contribution which is in general harmony with the ideas of certain other investigators who are dissatisfied with the more orthodox views on evolution.

Dr. Arber's essay was written after the publication of the first of the series of memoirs by Dr. Kidston and Professor Lang on the structure of the Middle (or possibly Lower ?) Devonian plants discovered a few years ago by Dr. Mackie in Aberdeenshire; but he did not live to see the later parts, the contents of which would probably have led him to reconsider some of his conclusions. Dr. Church's essay on "The Thalassiophyta and the Subaerial Transmigration," referred to in a previous number of DISCOVERY, would undoubtedly have appealed with considerable force to Dr. Arber had he lived to see it.

Unfortunately, most of the remains of the oldest known land-plants preserved in the rocks of the earth's crust are fragmentary, and with few exceptions afford little evidence of anatomical characters; the literature in which they are described is scattered, and in many instances difficult to obtain. But such records as there are demand the closest scrutiny by seekers after origins. Dr. Arber's concise descriptions of the several genera are particularly welcome, aided as they are by many well selected and admirably reproduced illustrations. The older Devonian flora, called by the author the Psilophyton flora, from the occurrence in many localities of the genus *Psilophyton*, differs widely from the latter, or *Archæopteris*, flora, which includes undoubted ferns and other Vascular Cryptogams, with a few representatives of trees presumably bearing seeds. It is contended that the members of the Psilophyton flora should be regarded as Thallophyta, despite the fact that in their organisation they had advanced beyond the limits of that group as we now understand it. The most highly differentiated living thallophytes are certain seaweeds adapted to life in water, but in the older Devonian thallophytes it is maintained that we have an added complexity of structure which was the result of their transference to a terrestrial habitat. The different groups of vascular plants represented in the Upper Devonian rocks are believed to have been derived from different ancestors which were algal in nature, a view which has much in its favour.

In Dr. Arber's book the student conversant with the general trend of modern speculation on the evolution of plants and with recent palæobotanical researches will find much to interest him and to make him think.

A. C. SEWARD.

Instinct and the Unconscious. By W. H. R. RIVERS, M.D., F.R.S. (Cambridge University Press, 1920, 16*s*.)

Let it be said at the outset that Dr. Rivers has given us a book that must be read and discussed, and that will be enjoyed whether or no it will be agreed with. Although confining himself to broad principles, he yet breaks new ground; and by laying stress on the biological side of psychology, he does a service to both sciences.

The contrast between a treatise such as this and the textbooks of psychology in vogue twenty and thirty years ago is remarkable. There is a new spirit in the air, and the new spirit is the outcome of a new method. In chemical science, the outstanding feature of modern times has been the rise of physical chemistry. The study of processes has proved the most illuminating and economical method of dealing with the multiplicity of fact; the dynamic has supplanted the static.

The same change is coming over psychology. We used to think of a curious being called the Ego installed somewhere in the chariot of the brain, and driving a rather mixed team of horses—Will, Intellect, Emotion, Memory. There was, of course, a certain amount of interaction—now and again Emotion would kick Intellect, Memory would jib and pull the rest up, or Will would need a touch of Ego's whip; but on the whole there wasn't much trouble of that sort, and good driving would get the team along.

To-day, charioteer, chariot, and horses alike are lost, merged in the conception of a single co-ordinated whole whose parts, though differentiated, are all in a state of equilibrium one with another, so that one cannot be altered without altering all the rest.

The most important single aspect of this state of balance is the dominance of some parts over others. The whole nervous system, whether regarded on its mental or its purely neural aspect, is a hierarchy, in which every part is being controlled from above, and is controlling other parts below. Normal mental health consists in striking the right balance between the lower centres—for the most part those concerned with the primitive instincts—and the higher centres—those concerned with altruism, with the highest types of emotion, and with the reason. As Dr. Rivers points out, this balance can be upset in either of two opposite ways, but with the same general result. Either the subordinate processes may be unduly strengthened, or the controlling processes may weaken. The conflicts of adolescence are due to the former cause, the neurasthenia and so-called shell-shock of adults to the latter.

It is of the utmost interest to find close parallels between the mode of interaction of the parts of the mind and that (at least in the simpler, more plastic organisms) of the parts of the body.

In the organism, regarded merely as a physiological machine, we are also brought face to face with a system composed of a number of parts in equilibrium, some parts being dominant over others. It is impossible to go into details here, but those who care to pursue the subject in books like Professor Child's *Individuality in Organisms*[1] will find the most suggestive parallels.

How comes it that such parallels exist? It proceeds from the fact that the only type of living system which can succeed in the struggle for existence must possess both diversity and unity. It must possess diversity to cope with the different problems propounded to it by the environment, it must have unity in order to subordinate one function to another according to circum-

[1] C. M. Child, *Individuality in Organisms.* Chicago, 1915.

stances, in order to be able to bring all its forces to bear upon any one particular problem. With the diversity we are familiar enough. The unification, however, is not so familiar. A very specialised method for achieving it is seen in the ductless glands of vertebrates; more primitively, we can simply say that each part has a reaction upon every other part, whether chemically or mechanically, so that the whole is not merely the sum of the parts, but the sum *plus* the interaction of the parts. This has long been known; but the relation by which a higher, controlling portion regulates and inhibits the rest —this has only recently come to the fore as a general principle of biology.

In a worm the front end of whose body has been cut off, the first structure to regenerate is a head; this once formed, the other missing organs are formed in due relation to and at normal distance from this head. But if we prevent the formation of a head, as we can by cold or by narcotics, the rest of the missing organs will never form. In a similar way, in the normal man there are certain reflexes which the spinal cord will carry out. When the connection between cord and brain is severed, these reflexes disappear, and, as Head and Riddoch have shown, quite new and much more primitive reflexes (of the sort that characterise toads and other low vertebrates) take their place. How is this possible? Normally, the reflexes are compounded of the activities of the spinal cord and the controlling influence of centres in the brain: remove the latter, and the unmodified activity of the cord appears as something new.

Many other parallels could be drawn, particularly between dedifferentiation, when whole organisms revert to a simpler stage, and regression, when human minds run back to the state they exhibited in childhood: but space forbids. The comparison is of value, however, for it demonstrates—what specialisation is always doing its best to obscure—the essential unity of all life.

The bulk of Dr. Rivers' book is devoted to the different types of neurosis and psychosis—anxiety-neurosis or neurasthenia, hysteria, dissociation, regression, phobia due to repressed complexes, and so forth, with a discussion of the underlying concepts—of instinct, suggestion, suppression, sublimation—on which he bases his analysis.

In accordance with the dynamical idea set out above, he considers all the abnormal mental conditions as upsets of equilibrium which represent crude and inadequate methods of attempting to solve a conflict between parts of the mind. The properly-developed mind is one in which every part, even the "lowest" instinct, is strong and active, but every part is properly subordinated in its due place in the hierarchy. An instinct is only bad when it escapes from control. Repression of primitive instincts and emotions is a mere drying of the springs of action. It is when instincts are powerful but sublimated rightly—piped off to drive the wheels of intellect and will —that real health of mind is found.

There is one general criticism which may be raised. It is a curious commentary on the method by which science progresses that the psychologists and physiologists are now laying that great emphasis upon adaptation which they deplored in the biologist forty years ago. The biologist meanwhile has moved on, and, while fully conscious of the importance of the adaptation-concept, is finding that much of what he thought at one time to be adaptive is in reality a direct and necessary consequence of the constitution of living matter. Dr. Rivers thinks of the psychological mechanism of suppression as having come into existence in response to a need for more delicate graduation of response in some cases, for immobility in others; he looks for the cause of dissociation in the alternation of land and water in the life of Amphibia. There is much to be said for this view; but the future will probably show that it is not the actual mechanisms which have originated thus, but only specialised conditions of the mechanisms, which themselves are inevitable by-products or ingredients of a highly-organised nervous system.

An analogy from biology will make my meaning clear. The property of regeneration is obviously useful to the organisms which possess it. Which of us would not like to be able, if we lost a hand or a head, to grow a new one? During the latter half of the nineteenth century it was strenuously maintained by leading zoologists that the power of regeneration was adaptive, and had originated during evolution through natural selection. A careful study, however, of the method and occurrence of regeneration has shown that this is not so. Regeneration is an inherent property of life, a necessary outcome of the fact that an organism is a system in equilibrium, and that, when that equilibrium is upset by the removal of a part, it is re-established in the same way as is a chemical equilibrium. Later on, in some organisms, this power has been specialised, adaptively, while in others it has been sacrificed to more important qualities.

Mental dissociation is probably a close parallel. Given a psycho-neural system capable of associative memory, a break between one part of the system and another may be made by various agencies; and if this happens, the two divided parts will round themselves off into a condition of equilibrium and be capable of a more or less independent existence: the possibility of dissociation is given by the nature of the system itself. No doubt but that machinery for more prompt and efficient dissociation (as in animals exhibiting immobility in response to danger) will be later developed through natural selection. Similarly with hypnotism. Given some mechanism of suppression and of suggestion, a large part of the phenomena of hypnotism follow naturally, without our having to ask what the biological meaning of hypnotism may be.

This is not to detract from Dr. Rivers' brilliant use of the biological method, which illuminates biology equally with psychology: it is merely to point out a limitation and to suggest another view-point which, as a matter of fact, has abundantly justified itself by results in the parallel but more developed science of biology.

Dr. Rivers' judicial view of the position of Freud and his theories in modern psychology will, it may safely be asserted, prove to be that which will be adopted by the historians of science. The experience of the war has

shown that Freud was wrong in one essential—sex does not necessarily underlie all neuroses. Any primary instinct may do so; and in war it is the conflict between fear and the higher centres which is by far the commonest cause of conflict. But in a still more fundamental matter, Freud was right. He drew attention for the first time to the mental mechanism by which these abnormal states arise. The concept of suppression, of active but instinctive forgetting of the unpleasant, with subsequent formation of complexes, is, as Dr. Rivers rightly says, one of prime importance to the theory and practice of psychology.

We hope that Dr. Rivers will give us a continuation of his essay. Case-records analysed from his particular standpoint, with detailed parallels from biological sources would be immensely interesting. So, too, would be a consideration of neuroses in savage peoples—a task which Dr. Rivers would be peculiarly qualified to undertake. A new "Golden Bough" on psychological lines . . . we close in pleasurable anticipation of such a possibility!

J. S. HUXLEY.

Miscellany

A REVISED edition of the famous Greek Lexicon known to all students as Liddell and Scott is shortly to appear. The last edition was revised in 1897 and published at two guineas; the forthcoming edition will be sold at four guineas, or in separate parts at a slightly higher figure. The need for a revision has long been appreciated by the Oxford University Press. The discovery, since the last substantial revision of the Lexicon, of the *Constitution of Athens*, the poems of Bacchylides, the mimes of Herodas, and a large number of fragments of classical literature, both from the works of authors such as Hesiod, Pindar, Sappho, Alcæus, and Callimachus, and from those of other writers who were previously little more than names to us, has added a considerable number of new words and early examples, or new uses of known words. The study of the numerous non-literary papyri has immensely widened our knowledge of Hellenistic Greek, and has introduced us to a new technical vocabulary in connection with the administration of Ptolemaic and Roman Egypt. During the same period the discovery of fresh inscriptions and the correction of the text of those already known have been constant. The science of Comparative Philology has been transformed and the history of the Greek language more fully explored. It is good, therefore, that the Lexicon should include all the necessary additions and modifications, and drop out (as it is doing) words from late or ecclesiastical writers whose place is more properly in a lexicon of Patristic Greek.

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The Cambridge University Press hope to publish by next October the first of a series of monographs on recent developments of physics which shall serve as supplements to Dr. N. R. Campbell's *Modern Electrical Theory*. It is difficult to keep such a book abreast of the times by means of new editions; accordingly the plan is proposed of issuing monographs, each corresponding roughly to a chapter of the book, the collection of which will in due course replace the book.

The monographs will be edited by Dr. Campbell, but he will not write all of them. The authors will not be, however, experts in the branches of physics concerned, for it is felt that a critical survey of a subject such as is appropriate to a textbook is more easily adopted by those who have not made important contributions towards it.

The first three monographs of the series will deal with Spectra, the Quantum Theory of Energy, and the Constitution of Atoms and Molecules.

This is extremely sound sense. The problem of keeping a scientific book reasonably up-to-date is a difficult one. One way is by the method described above; another is by issuing the book in a loose-leaf form. In the latter case those pages containing statements which subsequent work has rendered out-of-date may be easily removed, and pages, issued to purchasers of the book by the publisher, containing the latest and most acceptable views inserted in their places.

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Pessimists must be having a bad time of it at present. So many people are giving them nasty knocks. Publishers, for example, will persist in bringing out the most excellent books, carefully edited, nicely printed, and pleasantly bound, as though they were completely in ignorance of the pessimist's view that the world has gone completely to the dogs. The Cambridge University Press is going to bring out a new edition of Shakespeare's works. Sir Arthur Quiller-Couch is joint-editor with Mr. Dover Wilson, the well-known authority on the text of Shakespeare. It is quite evident that the series will be a most valuable one. It is true that editions of Shakespeare multiply; but it is now many years since the last attempt was made at a complete recension of Shakespeare's text, based upon a study and comparison, line by line, of the existing materials. And it is refreshing, after a study of Shakespeare at school, to read through an edition containing the text as near as can be discerned to that given by the author to his printer under the well-informed, clear, and accurate guidance of "Q" and his collaborator. The first of the series—*The Tempest*—has already been published.

The Oxford University Press is issuing a series of little books dealing with international, financial, industrial, and educational problems of to-day. Each book deals with a subject in a simple but authoritative manner. Instead of getting anybody to write these books, Mr. Victor Gollancz, the editor of the series, hit upon the excellent idea of asking men to write who really knew what they were writing about. The result is a series which one may confidently recommend to our readers. Sir Harry Johnston writes of the Backward Peoples and our relations with them; Mr. Baumann, of *The Saturday Review*, is writing on The Press, Mr. A. G. Gardiner on the Anglo-American Future, and Professor Pigou, of Cambridge, on A Capital Levy and Levies on War Wealth. About twenty volumes have been, or shortly will be, issued. Each has about seventy pages and costs half a crown.